INDIAN TEA

ITS CULTURE AND MANUFACTURE

BEING A TEXT-BOOK ON THE CULTURE
AND MANUFACTURE OF TEA

BY

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FOURTH EDITION

With 39 Illustrations and Plan of a Factory Building.

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PREFACE TO FOURTH EDITION.

THE author has endeavoured to add to the usefulness of the book by careful revision, and by eliminating all unnecessary matter, while adding reliable information from recent study and research. The scope of the work is still limited to the demonstration of such scientific facts and results as have stood the test of practical experience.

Considerable additions have been made to the chapters on Drainage and Manuring which will repay careful perusal and study by all interested. The chapter on Cooly Lines and Sanitation has been enlarged to deal with the latest discoveries in the Health Department. A Sketch Plan is added illustrating a simple and practical form of Septic Tank.

The illustrations in the chapter on Green Manuring are reproduced by kind permission of the Agricultural Adviser to the Government of India.

C. B.

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INDIAN TEA.

CHAPTER I.

CULTIVATION.

Importance of cultivation.

CULTIVATION is perhaps the most important operation on a tea estate, and yet in the large majority of gardens there is no class of work which receives less study or attention. This has always been so, although a recent writer has said: "In my opinion, it is an unfortunate circumstance that tea cultivation has come to mean mere surface hoeing." In tea culture it is supremely necessary to get all the aid obtainable from science and experience, because the circumstances are unique, and the details of this work probably require more attention than in any other branch of agriculture. The tea plant being permanently in the ground, it must be treated differently from ordinary farm work where annual crops are raised, and where the principal cultivation is done at a time when there is no crop in the ground. It is different even from fruit farming or coffee growing, where the harvest time is but one month in the year, whereas our tea plant is yielding its crop continuously for eight months on end, and in some places for the whole year round. Hence it follows that mistaken ideas regarding the nature of plant growth or a systematic ignoring of the principles of the science of agriculture may, and does, result in loss of crop, with more or less permanent damage to the plant which yields it.

Objects of cultivation.

The first object of cultivation is to kill or dispose of such vegetation as may be found occupying the ground, including all plants and trees whose presence is inimical to the health or prosperity of our tea plant. In what is called virgin soil, the surface is covered with a layer, more or less thick, of vegetable deposit or mould, the produce of rotted leaves and other decayed vegetation accumulated for many years; this mould has to be mixed with the soil to a certain depth, as it contains the most important nourishment for our plant, and it must be placed in such a position that the feeding rootlets will find ready access to it. For this reason it will be seen that in opening new land it is very desirable that the digging should be deep and the soil thoroughly well mixed, in preparation for the plant which is to find in it a permanent home.

Vegetable mould.

Deep cultivation.

When the land is deeply cultivated in the first instance, the plants will be enabled and encouraged to throw out lateral feeding roots down to a good depth below the surface. When the digging is shallow, however, especially in the case of stiff soil, the formation of feeding roots is only at or near the surface of the ground.

Forest land.

The next consideration is that the land requires to be rendered porous and permeable. Forest land is so to begin with, because the roots of trees and shrubs have been continually increasing in bulk and forcing up the soil; whilst a certain proportion of plants and trees have been dying annually and their decaying roots have formed temporary channels in the soil in all directions. When the culture of tea has been commenced, the conditions of the land are changed, and the soil must be turned up periodically and pulverized, in order to keep it in a sufficiently porous or permeable condition, it being highly necessary that our

plant roots should get air as well as water, and in order that the very fine hairs, which are thrown out by the roots in search of food, may meet with as little obstruction as possible.

Air and water.

Weather.

The action of sunshine and light, heat and cold, the pattering of raindrops, etc., all have either mechanical or chemical effects upon the soil exposed upon the surface of the ground, disintegrating its particles and rendering certain portions easily capable of digestion by our plant, which requires both mineral and vegetable food; hence it is necessary to turn over the soil at intervals, so that the prepared food may be placed near the feeding roots and that other portions of the soil may, in their turn, be subjected to the same process.

Structure of tea plant.

In all questions affecting this subject it is important to remember the structure of the tea plant and the manner in which it feeds upon the soil. Underground, the tea plant forms a tap root, which descends as straight as possible into the soil, sometimes to a depth of as much as eight or ten feet or even more. The natural use of this root is to hold the plant firmly in position; it extracts little or no nourishment from the ground, but in seasons of drought it is of great importance in absorbing moisture for the plant from its great depth. From this tap root, immediately under the surface of the ground, extend arms or branches ramifying in all directions; these again throw out tiny fibrous rootlets, like white hairs, which naturally find their way into the portions of the soil which are most readily accessible, and which contain plant nourishment. The root branches do not themselves feed upon the soil, as their fibre is too dense and hard. The feeding is all done by the thread-like rootlets, which are soft in their construction, and they absorb nourishment in a liquid form from the soil in which they find themselves.

The manner in which plant life is exerted and is sustained is most interesting. The immediate effect of the heat of the sun upon the leaves is evaporation of a portion of their moisture; this has to be replaced from the branches, stem, and root in their turn, and finally the rootlets have to extract it from the ground. The liquid which they absorb, however, is mixed with a variety of mineral and vegetable substances in solution; these substances are thus, in process of time, carried up into the leaves, where the digestive organs of the plant are mostly located. Here the crude sap is elaborated, under the influence of air and sunshine certain gases are developed and absorbed, and the sap thus changed; and reconstructed becomes fitted for plant nourishment.

Circulation of plant sap.

Digestion.

A separate system of circulation now carries this life blood to the twigs for the formation of new shoots and down the inner bark, or the cambium, between the bark and the woody-fibre, right to the roots, distributing nourishment and growth wherever required. Besides the ordinary building up of plant structure, the sap is capable of adapting itself to special circumstances; healing wounds, resisting the attacks of insects and disease, and even establishing new growth to replace members which have been torn or cut away.

Return circulation.

Behind these external indications of plant activity, there is within the plant itself the principal motive power, without which no outside influence could be of any avail. The mysterious centre of life has sometimes been supposed to exist in the roots, all the phenomena of growth being attributed to Root Power; but anyone who has had a little experience of raising rose plants from cuttings can tell that sometimes a cutting will make rapid growth for a time, and seems

Root Power.

to succeed splendidly, throwing out quite a number of new leaves and shoots; but after a time it suddenly dies and dries up. On lifting such a cutting, it will probably be found to have failed in forming any root whatever. In this case the circulation of sap, and consequent growth, could not possibly be attributed to root power, because there was absolutely no root in existence.

Vital Force.

The true power behind the active phenomena of plant growth is the life principle, or, as Science terms it, "Vital Force." Wherein lies this vital force no one can tell. Its manifestations are present in every part of the plant, and it is carried by means of the seed to succeeding generations.

Solar activity.

People sometimes, however, attribute too much to the direct action of the life principle; the passing of moisture from the leaves being described as "transpiration" and of oxygen as "respiration"; but that much of the action is due to solar activity can be proved by cutting off a branch and observing how rapidly the leaves lose their moisture and become shrivelled up by evaporation.

Effects of very wet weather.

The ideal weather for growth is when there is sunshine and shower alternately, because evaporation is rapid and a plentiful supply of moisture is made available for the roots to supply the place of what is taken away. When growth circulation has become established, it goes on for a time even in continuously wet weather when there is no evaporation whatever from the leaves, but it gradually becomes more feeble, and sometimes almost ceases. The new leaf produced at such times makes usually very poor tea, as the sap is watery, and the plant has not been in sufficiently vigorous circulation to elaborate the substances necessary for the production of thick juice.

Sap never down.

The sap of the tea plant is never actually *down*, as is commonly supposed, because it is an evergreen, and the leaves are subjected to the process of evaporation throughout the intensely dry months of the cold season ; hence there is a certain amount of circulation going on all the time, the roots supplying the necessary moisture from the soil to replace what is daily taken away, and the plant cannot be said to be at any time actually dormant. It may be described merely as inactive during winter.

The case is different with deciduous plants, such as most fruit trees, which are completely dormant in the off season. They may then be taken out of the ground with impunity, and without a particle of soil attached to the roots, but merely wrapped up in a little straw, may be carried for thousands of miles, and replanted again without in the least impairing their vitality. For this reason fruit trees may, and often do, have the soil scraped away from their roots for a time in winter, before the fresh application of manure.

Exposing roots.

On some tea gardens a custom of exposing the roots of the bushes for some weeks in the cold season has been in vogue. This is a practice which has been found to favour the development of fruit upon fruit trees, and its effect upon tea also can only be in the direction of making the bushes more "*seedy.*"

Tea plants will not stand being disturbed in the cold weather, and any attempt to transplant them then, except with an *unbroken* ball of earth, is certain to result in failure.

Deep cultivation.

The time for deep cultivation is undoubtedly the autumn, immediately after the rains are over and growth of leaf has nearly ceased. The ground is then covered more or less with

succulent weeds, which, with the surface soil, should be buried as deeply as possible. For this work one thoroughly good digging is worth more than four or five diggings of a slipshod character. A multitude of white rootlets may during this process be torn away, but this need cause no alarm, because the plant will throw out a new set in the spring, and it is the *new* rootlets which are the important feeders. Great care is to be exercised that no root *branches* are injured or torn away, and also to see that any which have been inadvertently brought to the surface are carefully replaced again at the proper depth. This leads to the question as to what implements are best for this work. The *khodallie fork* is undoubtedly best for level ground, if carefully manipulated.

Cutting roots.

Implements.

The hoe or *khodallie* is very objectionable, because it is so apt to clip away root branches, and sometimes, when it does not actually accomplish this, its edge scrapes a long gash in the bark of the root, this wound often resulting in a suppurating sore more or less serious. In gardens with very light sandy soils it may be necessary to use the hoe, simply because the soil is too loose to be lifted up between the prongs of a fork.

The practice of leaving the soil in large clods exposed to the action of sun and wind during the dry season is a very great mistake. It has been advocated even quite recently by some writers who might have been expected to know better. All the best authorities in scientific agriculture unite in pointing out that, if moisture is to be retained in the soil, the surface must not only be broken up, but must be thoroughly pulverized and made into as fine a powder as possible. The idea of having the soil in large clods is undoubtedly copied from the farmers in England, who go in for deep

Large clods.

Pulverizing soil.

and rough ploughing in the autumn in prospect of their spring crops, and who leave the surface as rough as possible for the winter, with very satisfactory results. The conditions, however, are quite different, because :—

1st—There is no crop in the ground at the time.

2nd—There is no *dry* season coming on.

3rd—The farmers expect rain and snow and frost, which will unite to disintegrate the lumps and make them " weather down."

4th—Before sowing anything the farmers break up the soil again, either by light cross ploughing or harrowing, and thoroughly pulverize the whole.

Retention of moisture.

In Australia, where the climate is always rather a dry one, fruit farmers as well as all classes of agriculturists recognize the necessity of pulverizing the soil thoroughly in order to retain moisture. In the drier parts of America also the same fact is now fully recognized, and in the December 1898 number of the *Journal of the Agricultural and Horticultural Society of India* an article appeared containing this theory of fine cultivation and making out that the wonderful discovery had been made by a certain Mr. Campbell, of California. The facts, however, have been known for a good many years and the system put into practice by a leading planter of Darjeeling as far back as thirty years ago, or more, with results which have been unvaryingly satisfactory. It is strongly advocated by Dr. Voelcker, Dr. Mann, and other scientists.

Law of evaporation.

As the tea plant remains green throughout the dry season, it requires a continuous supply of moisture, and in places which are specially subject to drought, it becomes the more necessary to study closely the laws of evaporation. A very common error is to suppose that cultivation dries up the

land, whereas exactly the opposite is the case. When a season of drought comes on the sun and the dry air combine to evaporate the moisture from the soil at the surface of the ground. As the moisture is removed, the vacancy is filled up partly by the soil coming gradually closer together or contracting; this naturally causes cracks or fissures to take place all over the ground, the fissures increasing in size and depth as the drought proceeds. These fissures now become so many funnels, up which rushes the moisture from the subsoil into the atmosphere, and so the land rapidly becomes dried up. Under such circumstances the object of cultivation is to break up the surface soil as minutely as possible and to a good depth, thus choking up all the funnels and arresting the upward rush of moisture. The pulverized soil, in this case, acts like a blanket, keeping off extreme heat from the roots of our plants, and also supplying them with the moisture which has been arrested in its upward rush.

Soil cracks.

Effect of pulverizing soil.

Whether on level or hill ground, only once in the year should really deep digging be done. The depth should be fully nine to twelve inches, and in some places even more if possible. On the approach of the rains, on level country, light digging is the rule, and should be repeated as often as there is at least six inches of jungle to bury. Deep digging in the rains is positively pernicious, because of the damage done to the new rootlets; these are busy utilizing the food which was provided for them by the deep digging in the cold weather, and the best results will be obtained if they are undisturbed and allowed full scope. The objects to be attained by the light digging are to keep down weeds and to keep the surface open for the reception of rain and air, besides the warming influence of the sun.

Frequency of digging.

Root growth.

In tea culture, a very important fact to be borne in mind is that the bushes make their root growth chiefly in the early spring. There is very little growth of root after mid-season.

Weeds desirable.

It is always desirable to have some weeds to turn in at every digging, provided they have not been allowed to grow too tall, and provided that they are not of a harmful nature. Weeds of a leguminous nature are known to be very beneficial to the soil.

Deep digging.

Wherever sufficient labour is available, it is a good plan to give specially deep digging to one or two blocks each year ; especially such blocks as show signs of requiring special treatment ; the depth of digging being 18 inches or more. This treatment has been tried on certain estates, and the beneficial effects have been seen for years afterwards ; in fact, the chief benefit is seen only after a year or two has elapsed. This sort of work should be done, however, only in the season when the bushes are inactive (December and January) ; otherwise, the bushes get too severe a shock through the inevitable damage to growing roots.

Trenching.

Deep trenching is also a measure which can occasionally be adopted with great advantage ; especially on level country or on fields where there is a moderate slope on hill gardens. The trenches are dug, the width of a *khodallie*, to a depth of 18 inches or more. Dr. Mann has drawn special attention to this in his reports on Tea Soils ; urging the necessity of getting deep enough to break through the

Hard pan.

hard pan which is so commonly found immediately below the usual depth of cultivation, especially on low-lying lands, and which forms an almost impassable barrier to drainage from

above and capillary attraction from below, while at the same time resisting all attempts of the tea roots to penetrate to a sufficient depth.

Trenching has increased in favour during the last few years, and is now the rule on most estates under progressive management. On some gardens a specially made hoe is in use for this work. It is only about four inches wide, and a cooly can dig narrow trenches with it very rapidly. This is of importance where the labour force is not strong; but its great disadvantage is that by this means only a very small area of the ground is broken up, whereas the ordinary *khodallie* makes a trench about double the width, and gives quite 50 per cent. better results.

Trenching is to a large extent also a drainage operation, as it assists the subsequent movements of water in the soil, helping to prevent stagnation.

The frequency of this operation on any block may be determined according to circumstances. As a rule the same block may be treated once every two or three years. It is desirable that the depth of trenching be varied each time, between a limit of 18 and 24 inches, so as to avoid forming a hard pan at any particular depth. The direction may be altered each time, so as to cross the previous lines of trenches.

The best time to do trenching is just before pruning, after which the prunings are mixed with the soil when refilling the trenches.

Dead soil.

The importance of this work will be apparent when it is remembered that all soil within and under a hard pan must be "dead"; hence the prunings and any other organic matter, which can be added, will not only assist in keeping open the soil and establishing better drainage, but will also supply

a nucleus for nitrifying bacterial activity. If there is any jungle land within reasonable distance, a large quantity of leaves and twigs can be carried to the trenches, adding enormously to the value of this work.

Green manure.

Different kinds of soil require different treatment. Light sandy soils require much less cultivation than clay soils, because they are naturally so open and admit rain, air, etc., comparatively freely. Every effort should be made to encourage and conserve suitable green growth on such land, and to turn it into the soil while green at a well-developed stage, because such soils are usually rather deficient in organic matter (animal and vegetable débris) and they part with such matter so readily.

Classes of soil.

It has been found that if green growth is partially dried before burial its fertilizing properties are not greatly decreased. Green stuff may be cut and left lying upon the ground for one or two days before burial under the soil. By that time it will have lost 25 per cent. of its weight by evaporation of moisture, and it will be flaccid and easily disposed of.

Green growth.

Cold clay soils are deficient in organic matter because having been in a more or less water-logged state, the best forms of animal or vegetable life have not been able to exist in them. The first necessity for such soils is of course subsoil drainage, and until that is attended to, all the expenditure on digging will be practically wasted. Stiff clay soils in a healthy state contain a certain proportion of organic matter, but they need to be cultivated in such a manner as to counteract the stiffness and render them more free and permeable. If such soils are dug during heavy rain, they are rendered still more stiff and plastic, but sunny

Subsoil drainage.

weather is the ideal time for such cultivation and, if possible, the weeds which are turned in should be in a dry state, in which condition they take longer to rot, and so act more in the direction of freeing or opening the soil. When an estate possesses portions of land with different kinds of soil, it is possible to so arrange the work that the lighter portions will receive attention in wet weather and the stiff soils get a good digging during sunshine. Peaty or bheel soils contain a large excess of organic matter with which they part rapidly on being brought under cultivation, the crops for a few years being sometimes phenomenal, but this is soon used up and the ground assumes the character of ordinary light soils.

Digging in rain and sunshine.

It is possible to carry cultivation to excess, even in level country, and the effects of keeping the soil continually turned over, exposed incessantly for years to the influence of the sun, etc., are that it is forced to part with too large a portion of its fertile constituents, together with all organic matter, and is brought into a comparatively barren condition. It must be borne in mind, however, that mere cultivation cannot *permanently* injure the soil, provided that there has been no portion of the soil actually washed away by floods or superficial drainage. One of the best authorities in scientific agriculture has remarked that "no system of husbandry, however improvident, is capable of permanently deteriorating the productive powers of the earth." The reason for this is that the mineral constituents are in superabundance, but are so locked up that the dissolution is extremely gradual, even in the most favourable circumstances.

Over-cultivation.

Over-cultivated soils need only a period of rest in order to return to their former fertility, which recuperation can be greatly facilitated by a system of suitable green manuring.

Bury or burn prunings.

Should prunings be buried or burned? is a question often asked. Many planters of experience have put the question to the test, and have tried burning in the hope of subduing or eradicating certain pests, such as red spider, mosquito, etc., but the results have not been found satisfactory.

Ashes of prunings.

Valuable manurial properties have been destroyed by burning the prunings, while as compared with other gardens where the prunings have not been burnt, there has been no apparent result in the direction of subduing the various pests. Theoretically, the ashes are distributed to form manure for the whole ground: in most instances, however, this is mere theory, as the ashes of an acre of prunings are usually distributed over but a few square yards of land.

The only occasion when prunings may with advantage be burnt is when tea has been subjected to heavy pruning. The woody portion of the structure, the stem and the main branches, may then be burnt, or may be taken by the operatives for firewood, on condition that the light twigs with leaves are first cut off and left upon the ground for manure. The woody portions consist chiefly of carbon, which is of no practical use as manure, because all plants take their necessary supplies of carbon direct from the atmosphere.

Lime. Basic slag.

Light prunings should invariably be buried. In the case of prunings which are affected by fungus blights, such as " Thread " or " Rust," even these may be buried without hesitation, provided they are covered over with a good depth of soil. The addition of a little quicklime or of basic slag is an advantage.

Modern science has demonstrated the fact that all fertile soils are inhabited by micro-organisms, or bacteria,

in such multitudes that the soil itself may be considered literally a mass of life. This fact has given rise to the expression "living earth," as distinguishing the layer of soil on the surface of the earth, down to the depth at which such conditions cease to exist. The business of these micro-organisms is chiefly to seize upon and decompose all organic matter which has been cast off or resulting from both animal and vegetable life. The work performed is termed "nitrification"; and is a process absolutely necessary before manure can be utilized by plant life. It is for this reason that common earth has been found to be a remarkable disinfectant; so that materials which, if left above ground, would be a positive danger to health, when buried in the soil are not only rendered innocuous, but are made of great practical value. These materials are seized upon by the bacteria within the soil, broken down or decomposed, and transformed into substances which form perfect nourishment for all kinds of vegetation.

Living earth.

Nitrification.

Disinfection.

The depth of the living earth varies greatly with the character of the soil itself, and with the treatment to which it has been subjected. Frequently a hard pan determines its depth. Within and underneath a hard pan of stiff clay, logs and branches of trees have been known to remain for an incredible number of years undecayed and unaltered, simply because of the absence of the micro-organisms whose business it is to disintegrate the material or cause what is termed decay. It is for this reason that subsoils are comparatively so sterile; so that the first results of very deep cultivation are pretty certain to prove disappointing.

Embedded logs.

When Government originally undertook to help Indian cultivators to improve their methods, the first

suggestion naturally was to plough deeper than had been the immemorial custom on the rice-fields of Bengal. The results of those early experiments in deep ploughing were the reverse of encouraging, and there can be no doubt that the reason was chiefly that the mixture of sterile or dead subsoil proved at first a hindrance instead of a help to the growing crops.

Deep ploughing.

A remarkable illustration of the difference between living and dead earth is found when an old village site is brought under cultivation. Such land invariably proves quite refractory for a number of years. On tea estates it has been found again and again that the old sites of houses simply would not grow tea, no matter how thoroughly the land was cultivated and pulverized. A case such as this came under the observation of Dr. Mann, as mentioned in his "Tea Soils of Assam," where an analysis of the soil proved that it was particularly rich in all the ingredients which make for fertility, and was as a soil in all respects "an exceedingly good one," but it "practically refused to grow tea at all."

Village sites.

It seems quite certain that the infertility in such cases is entirely due to the nitrifying organisms having been killed out by the beating down of the earth during many years, and the consequent exclusion of oxygen Dr. Aikman * has pointed out that anything which causes the exclusion of oxygen from the soil must of necessity result in the destruction of soil bacteria and the complete cessation of nitrifying activity.

It is occasionally necessary to plant out an old village site when it comes within the area marked out for extensions; and unless some special measures are taken to

* Johnston's Agricultural Chemistry, 17th Edition.

ensure success, the spot where the old village stood will show up as an unsightly bare patch for many years. The one way to make sure of success is to dig good sized holes at the time of planting, after thorough cultivation all over, and surround each plant with a supply of new living earth from the jungle, so as to provide it with nourishment till the soil bacteria become sufficiently disseminated. The mere application of manure in such cases is not sufficient.

Trenching prunings.

Prunings should be buried in a green state, immediately after being cut off the bushes, in which condition even heavy prunings will rot rapidly. The best plan for level country is to have trenches dug in the ground previous to pruning, into which the green stuff is thrown at once and covered over with the soil previously excavated. This may be done with every line, or every alternate line. In the case of China bushes, closely planted, it has been found most convenient to prune first, and then dig the trenches, burying the prunings and filling in again in one operation.

Trenches may be dug to a depth of 18 inches or more, but it is of importance to note that digging trenches of 24 inches deep costs about double those of 18 inches. It is not advisable to dig every year to exactly the same depth, as this encourages the formation of hard pan.

Ploughing.

Ploughing has often been tried upon tea gardens, but never with success, because the plough invariably tears up the lateral roots, and in any case the plough cannot get near the collar of the tea bush, which is the place most requiring to be kept clean. Engineers have often turned their inventive genius to this subject in the hope of finding some means of cultivating by other than direct manual labour, but thus far without success. Many years ago a well-known

tea engineer invented the "wheel hoe" for this purpose, but it did not justify the hopes of the inventor.

Digging *versus* Weeding.

The system of neglecting cultivation or only digging at rare intervals, as used to be practised in some parts of Ceylon, has something to recommend it in the direction of economy, for when hand-weeding takes the place of digging, it is soon found that weeds cease to grow, and the garden can be kept clean for a remarkably small expenditure. If, however, the weeds cease to grow so do the bushes to some extent, and Ceylon planters have found it necessary to resort largely to manuring, trenching it in at intervals, and this very trenching, of course, brings them back to the best kind of cultivation, opening up the soil to a good depth, the influence of both manure and trenching resulting in a very largely increased yield of tea.

Roots near the surface.

If hand-weeding only is resorted to, the plants send their laterals and feeding rootlets out towards the surface of the ground, that being the only place where the soil is in the necessary state for their food ; then the roots, being so near the surface, are the more subject to the vicissitudes of the weather, such as drought, etc.

A very good custom on many estates is to employ a gang of women or children throughout the hot weather, in digging round the bushes with small forks, pulverizing the soil and so making it open for the passage of rain and air to the roots by gravitation, and at the same time resistant to the influence of surface heat for evaporation.

Earthing up.

Earthing up round the stems of the bushes in the dry season is to be avoided ; chiefly because the earth for this purpose is taken from ground occupied by the *roots*, leaving these with less of a covering and consequently more liable to suffer from drought.

When the land has been properly prepared before planting, not much is required in the way of actual cultivation for the first year. Jungle must, however, on no account be allowed to grow up around the young seedling. Some young planters have a mistaken idea that a little jungle forms a protection to the plant from the sun, and is thus beneficial. There can be no shade from the jungle unless it overtops the seedling, and if this is allowed, the jungle, being the more hardy, takes all the nourishment which is going and thus more or less chokes off the tea. The young plant must be kept free of all weeds by hand-weeding and the soil round its collar gently broken occasionally, either by the point of a stake or a small fork. A large implement, such as a hoe or a large fork, must on no account be allowed near young seedlings, because the cooly is almost certain to put it in too deeply, and the roots are violently disturbed before they have got a good grip of the soil, the result being a heavy mortality.

Weeds no protection.

Breaking soil.

This is often the secret cause of the failure or partial failure of extensions; the plants are literally killed with kindness, and what was meant for their nourishment becomes their destruction. The mortality from this cause is not apparent at the time; the plants which are killed by the digging people remain green for a few days, just as a branch which is cut off and stuck into the ground would remain green for a certain length of time; hence the effect is only noticed after a time, and is not traced to its real cause.

Killing plants.

About a year or so after planting, the cultivation should be a little deeper, say to three or four inches and as soon as the plant has become fully established, deep digging may be resorted to. This should not be delayed too long, because the great object must be to

encourage the plant to form lateral roots as deep down as possible.

Some planters never dig the ground at all for the first three years, the theory being that the plant must be in a position to pay for its own cultivation before it gets any. This theory is manifestly a mistaken one.

Seedy tea.

The expression to become "seedy" probably has its origin in the fact that all trees and plants, when they become sickly, make a special effort to produce seed, so as to reproduce their kind before expiring. Fruit growers recognize the principle that with trees generally, a healthy vigorous condition tends more to the production of leaf and wood than of fruit or seed; hence they resort to various devices

Checking growth.

to check free growth by exposing or pruning roots, disbudding, fracturing branches, tying or partially ringing branches, driving spikes into the stem, etc. On the other hand, they recognize the danger of allowing trees to become too seedy, as indicated by an abnormal production of fruit, the most of which is then rigorously pulled off at an early stage. Sometimes the whole crop from a tree is sacrificed for one year, in order to save it from pegging out. To become seedy, therefore, is a sign of comparative weakness.

Weakness.

Seed takes an enormous quantity of nourishment from the plant, so that whenever it becomes at all plentiful on the tea-bushes, it may with great advantage be stripped off, especially if this can be done early in the season. Any block which shows a special tendency to weakness should be kept absolutely free of seed by this means.

In all kinds of culture, the coarser varieties tend to produce a larger quantity of fruit or seed, hence the China variety of tea produces much more seed than the

finer kinds ; and wherever labour is available, it pays well to have all the seed stripped off such bushes, while it is still in a pulpy state. The nourishment which would have gone to the maturing of the seed is then diverted towards strengthening the bushes and the production of new leaf.

HILL CULTURE.

If the system of cultivation for level ground is important, that for steep hill-sides must be of vastly greater importance, because mistaken methods or wanton carelessness can and do work incalculable mischief, even to the extent of utterly ruining many a valuable property. Naturally with steep land, the first consideration is to preserve the soil from being carried down the hill-side, and the whole system of cultivation must at all times keep this end in view.

Preservation of soil.

Terracing is of the greatest importance, but the terraces must not be too prominent, for several very good reasons, amongst which may be mentioned the following :—Terraces which stand out at nearly right angles are apt to break away in large blocks ; in dry seasons they suffer from drought ; in the rains they get overloaded with excess water, giving rise to dangerous possibilities.

Terracing.

If a good labour force is available, the chief cultivation is to be done immediately at the close of the heavy rains. This may be as deep as can be conveniently done, and the deeper the better. The implement used for the sloping or steep land should invariably be the straight garden fork, a *short* handle being always preferable. The *khodallie* fork is objectionable, because the cooly pulls the soil downhill with it, and even when working across terraces, he cannot lift soil from one terrace

Implements.

to another, which frequently requires to be done. The cooly soon gets into the way of using the straight fork, and in time can do almost as much with it as with any other implement, the work being immensely superior, and he does not bang the branches about so much.

One really good digging is all that is absolutely necessary for steep land for a whole year. The weeds which have been buried take time to rot, and they keep the soil in a comparatively free state, and if the surface is kept free of bad weeds, the tea plant will thrive very well. If prunings have still to be buried, or if a light crop of jungle comes on as a result of spring rain, one or two light forkings may be given with advantage, but as soon as the time for heavy rain draws near, all digging must be absolutely stopped, except on practically level ground, and the system of rains culture inaugurated and continued until the heavy rains are over, say the beginning or the middle of September.

Light forkings.

It is a strange fact that some planters do keep on digging steep land throughout the wet season, partly because certain other people do it, and partly in order to force their bushes to yield a little more leaf. At such seasons one has only to glance at the streams flowing down the hill-side, and with the aid of a little reflection will see that the garden itself is flowing away. The streams are thick and turgid and are coloured with the life-blood of the soil. The portion of it which is in a soluble state, and ready to be sucked in as nourishment by our tea plant, is being swept away by the flood and is thus gone for ever, leaving only the hard sand or shale, which will take years or ages of preparation before it will be rendered fit for the support of plant life.

Gardens flowing away.

This is not a mere fanciful picture. There are gardens in some of the hill districts, which at this moment are absolutely ruined, great portions of them being now incapable of producing more than one maund of tea per acre: many of the bushes standing with their roots exposed like the legs of a crab, their unhappy bodies being withered and shrivelled and sickly, because there is no nourishment left for them in the ground.

Actual loss.

The question has sometimes been asked: What particular constituents are most liable to be carried away by surface wash? The first and most important is undoubtedly nitrogen, in the form of nitrates, as prepared by bacterial action for plant assimilation. Nitrates in a solvent state are most difficult to retain in the soil. Another material which may be noticed is organic matter or humus in process of decomposition, which is readily carried away from the surface of the ground by a flood of rain. Potash, phosphoric acid, etc., are readily carried away to the extent that they are in a solvent state, and on the surface of the ground.

Silica or sand is the only material which is not readily carried off by wash. Anyone may observe this if he examines cultivated land immediately after a heavy downpour of rain. It is seen that the surface of the ground is covered with a layer of comparatively clean sand, proving that the soluble constituents, already mentioned, have disappeared; and the water which flowed over the surface of the ground into surface-drains carried a large proportion of these substances with it. The sand acts as a protection against further wash, so that the actual loss is only that portion of soluble soil exposed on the surface. When the rainfall is very heavy, even the sand is liable to be carried away, if unprotected by something growing in it.

The important point to note is that every time steep and is dug during wet weather, a new part of the soil becomes exposed to the onslaught of rain, and a new oss of valuable constituents is inevitable.

It is impossible to cultivate land on the hill-sides, ind keep the original soil absolutely intact, yet it is possible to arrange the system and manner of cultivation n such a way that the annual loss of soil will not be great, ind will be made up for by the gradual decomposition of the mineral or hard constituents of the land, a process which is going on all the time, and is of course accelerated by cultivation.

Rains cultivation.

Although on the approach of the rains all digging has to be stopped, the idea of *cultivation* is not to be abandoned. Light weeds are now allowed to grow, but only to a certain height. As soon as they get so tall as to impede free circulation of air to the tea, they must be either hand-weeded or cut down by the sickle ; the latter plan is probably the better, because the stumps of the weeds form an excellent check upon wash, and they form something like a filter for retaining any soil which might become detached by the onslaught of heavy rain or the heavy drippings from branches.

Weeding round collar.

It is of the utmost importance that where sickling is resorted to a circle of about a foot or more radius should be hand-weeded all round the collar of each bush. Planters who have not tried this can have no idea of the great value it is to the bush ; it keeps the soil open for the reception of moisture, etc., and it keeps the bushes wonderfully free of weeds for weeks afterwards. This work must be done thoroughly in order to be of real benefit, and the sickle must on no account be allowed to operate within a foot of the collar of the bush.

There are certain kinds of weeds which grow so rankly as to have a very pernicious effect upon the tea. These must not only be uprooted, they must be exterminated whenever they appear. Natives of different districts have their own names for these weeds, but the more important may, perhaps, be distinguished as *seroo, khurkia, oonia, dhoria, dhotesara, amlissa, kara* (of sorts), *manae,* etc. All these grow with remarkable rapidity in good soil, and almost invariably make their appearance on land which has recently been top-dressed or manured. If uprooted and left on the ground during the rains, they just take root again on the surface and are soon growing again as gaily as before. It is of great importance that they be removed before they flower and shed their seed, otherwise the following season will see a much larger crop spring up.

Rank weeds.

The only way to deal successfully with these weeds is to uproot them, and have a separate gang of men or boys to collect them into baskets and carry them off the cultivation. If this is done while the weeds are quite young and small, it entails very little extra labour. A good way to dispose of them, if labour is available, is to dig large pits or trenches within the area of tea and bury in heaps; if only a few are buried, they will soon sprout up again, but if in heaps, they ferment, and so get killed. The most difficult weed to eradicate on a hill garden is *seroo* or *sun grass.* It is a comparatively easy matter on the plains, where it is destroyed simply by frequent diggings; but on a hill garden the digging cannot be frequent, and is usually just enough to encourage and *cultivate* it. A separate gang of coolies has to be detailed for this work in the digging season, and the soil carefully dug over to a depth of 15 or 18 inches, all *seroo* roots being taken out to the surface and subsequently carried off. Terraces

Sun grass.

and revetments must be dug down in order to do this work properly, but they can be gradually made up again during the following season. After this has been done, a few ends of roots which may have escaped notice and remain in the ground will sprout up when the rains come on, but if these are at once *pulled out by hand*, the last traces of the enemy will disappear.

Ferns.

Oonia or *ferns* have a knack of lodging themselves at the collars of the bushes, and are specially troublesome in China bushes with their many stems. They are easily removed by means of a steel hook, and must be carried off as described above. A very common mode of dealing with ferns is to have them carefully taken out in the cold weather and placed on the tops of the tea bushes, where the sun dries them up, and they soon die. Planters who do this, however, wonder why it is that they have to do the same thing every year, and the ferns always appear again. The secret is that when they are placed on the bushes to dry, the sun ripens their *seed*, which drops into the centre of the bush, a perfect situation for it, and so a new crop is sown for the coming season. Ferns should not on any account be left on the tops of the bushes.

Jungle seeds.

When overseers are marking the spot when coolies begin work in the morning, it is customary to do this with strips of jungle or tall grass, and they are very fond of bringing for this purpose any kind of grass which is *in flower*, it looks so nice when stuck into a tea bush. They do not, however, realize that the flower means seed, and the seed means jungle of a pernicious kind being propagated amongst the tea

Revetments.

In the slack season, spare labour can be advantageously employed at building revetments to support roads or terraces in the tea,

especially in making terraces at intervals to prevent wash, and in building the upper bank of roadsides, when the soil has gradually got worn away, and roots more or less exposed. At such seasons also all roads can be repaired, and short cuts built with stone so as to form permanent paths for ready access of the coolies to all parts of the cultivation.

CHAPTER II.

DRAINAGE.

IT is now fully acknowledged that tea cannot thrive on sour or water-logged soil, and it cannot live in land which is subject to being flooded with stagnant water for any length of time. For gardens on level country, drainage is imperative.

The chief object of drainage, however, especially *deep* drainage, is not always understood. It is not so much to get the excess water away from the *surface* of the ground as to get it away from the *subsoil.* No system of drainage is perfect until the surface water, instead of flowing off the surface, will soak through the soil, and ultimately find its way along the subsoil into the drains. In this process the soil becomes a gigantic filter, extracting from the rainwater a quantity of nitrogen and other chemicals which it has brought from the atmosphere, and which are generally termed *impurities*, but which are in fact highly nutritious to the soil, and form a very valuable manure.

Natural filter.

Rain is not to be looked upon as supplying merely moisture to plant life ; it does a great deal more than that, and the more rain which can be got to pass through the soil, the richer will the result be ; provided always that the rainfall is not so excessive or continuous as to chill the ground. Even in such circumstances, however, the well-drained and aërated land naturally suffers much less than the insufficiently drained or water-logged.

Fertility from rain.

If, during the rainy season, a hole is dug on level ground to a depth of several feet, a point is soon reached where water covers the bottom, the water continuing at a fairly constant level during the wet season. This level is termed the "Water Table."

Water Table.

This table may vary on any block of land, owing to the differences in the character of the subsoil; but if the soil is in good condition for growing tea the water table is at least three or four feet below the surface of the earth. Wherever the table is higher than this the need for drainage is very urgent. No tea can live with its roots permanently in water, and no tea can make healthy growth so long as its roots are in water-logged soil for several months each year.

Weight of rain-water.

Few people realize what an enormous weight of water falls upon the earth annually in the form of rain. Every inch of rain means a fall of 101 tons on each acre of land; hence one hundred acres of land gets 10,100 tons from every inch of rain which falls throughout the year. This gives some idea of the amount of valuable manure which can be added to the soil if the water can all, or even a fair proportion, be made to pass through our filter instead of merely flowing over it.

Wash.

Another point worth noting is that when water flows over the surface it carries with it more or less of the surface soil, besides humus which ought to remain as manure.

During very heavy rain it is inevitable that some water must flow away off the surface, but in the case of healthily drained land the first onslaught of rain penetrates immediately into the soil, arresting and carrying below the surface all the manurial properties which have been prepared by natural means during the previous season of dry weather; whereas in the case of impervious

land all the rich feeding material is carried away with the first flood.

Another fact also is that the application of manure is little better than useless on land that is in need of drainage, even if the manure is buried well under the surface ; because such land is always deficient in oxygen, without which nitrifying bacteria cannot exist ; hence the manure remains to a large extent unappropriated. Its effect is lost.

Effects of drainage.

Heavy clay soils require more and deeper drains than light soils, because the latter are naturally more permeable, and the light soils are more liable to suffer from drought in the dry season if too deeply drained. After stiff soils have been drained, it takes some years before the best effects are seen ; but the soil gradually changes its character, and sometimes even its colour, as the effects of the drainage are felt, and it becomes more porous and permeable, especially if the system of cultivation is such as to help the efficiency of the drains.

Wet soil.

The most common cause of wet soil is rain-water which has fallen upon the land becoming more or less stagnant, owing to the subjacent strata being insufficiently porous. To the uninitiated it might seem very satisfactory that a block of land should keep wet on the surface nearly all the time ; but as a matter of fact, such land is most unhealthy, for almost every kind of culture, especially for a deep-rooting crop such as tea.

During dry weather the first few inches of the soil should readily become dry. If drainage is good, the surface will become both dry and friable during a drought, especially when assisted by careful cultivation, and will become a sponge to detain moisture as it rises by capillarity from below ; also it will hold the moisture

available for the roots of the tea growing in the soil. If the surface of any land is wet after two days of sunshine, this is an indication that there is stagnant water not far from the surface. The land is sour, and in need of drainage.

Capillary Attraction.

The principle reason why land does not become dried up by drainage is to be found in the natural law named "Capillary Attraction." An everyday illustration of this can be seen in using a piece of blotting paper to lick up a blot of ink. Just as ink rises up into the blotting so the moisture rises up from the lower layers of soil to replace water removed by evaporation, provided the soil is in a healthy state. In this connection certain experiments were made some years ago by Professor Wrightson, with a series of glass tubes filled with different classes of soil. The lower end of each tube was placed in water. The results were recorded thus: "Twenty minutes after the experiment was commenced the fine sand was wet nine inches above the level of the water in the saucers, and seven hours after it was wet fifteen inches up the tube. Clay, in a finely powdered state, had during this time only raised water three and five inches in height, taking two tubes containing similar soils. The capillary power of the sand was, however, almost exhausted in this short period, and although the experiment was conducted for 132 days the column of water was never raised higher than 23 inches. The clay behaved very differently. Although water rose slowly, it rose very steadily, and at the termination of the experiment, 132 days after its commencement, it was wet 35 and 33 inches, taking again the results of two tubes."

It is thus seen that capillarity is most active in sandy soil, but it affects a much wider range in clay soil. The agricultural value of the latter is enormously

increased by thorough drainage, especially if the surface is kept cultivated and pulverised. The depth to which the feeding roots can penetrate is greatly increased; so that the cubical area available for plant food is proportionately increased, and the plants can resist a season of drought by reason of active capillarity over a large area underground.

Cold Soil.

Clay soil is proverbially cold, because so much heat is required to evaporate water from it ; but this difficulty is eliminated when drainage is perfect. An important point also to be noted is that drainage does not carry away all the water from a soil ; it only removes a surplus. The drained soil remains saturated. Water-logged soil is "super-saturated." Viewed from this standpoint it is clear that no one need fear that a light soil can suffer from drought in consequence of drainage, provided that the drains are a moderate depth.

Distance and depth.

With ordinary soils the drains should be 30 to 60 feet apart, according to the stiffness or freeness of the soil, about three feet deep, sides slightly sloping, and of the width of a hoe at the bottom. Anything less than three feet deep is only a surface drain, and is probably rather pernicious than otherwise. Main drains are required at suitable intervals, about four feet deep and one and a half feet to three feet wide as the circumstances may require. The ordinary drains should be made to debouch into them at an angle, in the direction of the flow, coming in pairs from opposite sides, like fish bones. Triangular planting is specially suitable for good drainage. *Wide* drains are not desirable, as they allow the soil to get too much baked in dry weather. Before starting a system of drainage it is, of course, necessary to ascertain accurately the direction in which the land naturally falls, and make the drains accordingly.

For undulating lands, or lands which are almost level, it is impossible to arrange a suitable system of drainage without the aid of an instrument. The eye is a deceptive guide as to just how a gentle slope goes, and it not unfrequently happens that in a happy-go-lucky arrangement of drains an attempt is made to induce water to flow uphill. In such cases the amateur engineer has to begin over again, and not unfrequently the error is discovered only after a considerable area has been drained at great expense; and then when heavy rain has come it is found that some of the drains have water flowing the wrong way, until they partially fill themselves with water. As it is, depressions in drains here and there are quite common, and in these depressions there are always long pools of water remaining throughout the rainy season, until such time as the depressions get filled with silt to the level of the flow.

Depressions.

In the dry season, when drains are all cleaned out anew, the operatives naturally clean out each drain to its original depth everywhere, so that every depression is again ready to act as before, with long pools of water lying stagnant for days together, forming ideal places for the breeding of malarial mosquitoes. Where the depression of a drain is only a few inches below flow level for fifty or a hundred feet the planter is hardly aware of it, and is not conscious of the very real danger caused by the actual hot-beds of disease for his labour force, existing at intervals over perhaps a great section of his property.

If the drains are cut properly to more or less of a slope everywhere, indicated and proved by instrument, there cannot be any depressions or stagnant water anywhere, and there cannot be danger to the health of the labour force from this cause; also, the atmosphere cannot be polluted by

Mosquitoes.

bad odours from stagnant water and soil in an unhealthy state. It is a fact, established by Dr. Bentley, that flowing water cannot breed mosquitoes. The danger is wherever water lies quiescent.

The instrument generally used for laying out a system of drainage is the Dumpy Level; but although accurate, it is a clumsy method, and can only be used by a person who has been instructed in its use. It has to be laboriously and carefully set up at each point of observation, adjusted by spirit level. The Self-registering Clinometer which has recently been invented, and is now manufactured by a reliable firm of instrument makers, combines accuracy with despatch; no setting up is required; it can be arranged and clamped to indicate any desired slope with extreme accuracy, and can be used by any intelligent person without previous instruction. A Note of Instructions, with Table of Gradients, accompanies each instrument.

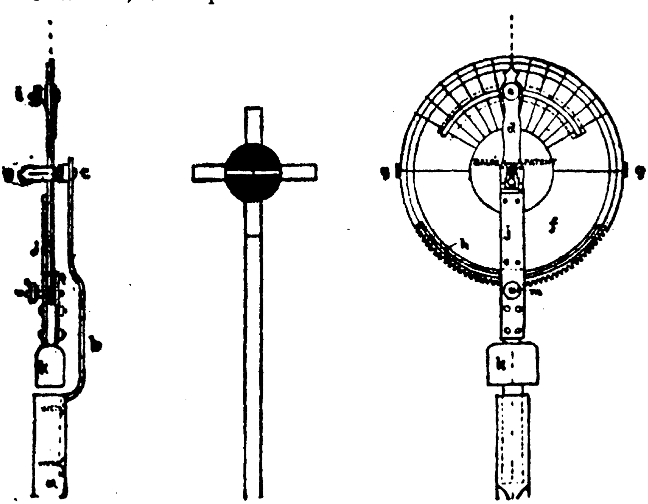


Fig. 1. Patent Clinometer.

There are many objections to the open ditch drains.

Underground drains. If any practicable means can be found for underground drainage it will be a boon to the industry. Not the least important consideration is that with the present system there is a considerable area from which the roots of the tea bushes are excluded. If the open trenches could be filled in with soil, with effective drains underneath, the roots of tea could feed in that soil better than anywhere else, because of the perfect condition of drainage obtaining there ; whereas at present there is a line completely lost at intervals all over the cultivated area, and the two lines of tea adjoining all the drains are liable to suffer from drought during any long spell of dry weather.

On one or two gardens in Assam, a system of underground drainage has been adopted which may well be copied on a large scale wherever sufficient labour is available. It is used for minor drains only, the main drains being of the usual open ditch style. A trench is dug to a depth of two feet and twelve inches wide all the way. At the centre of this trench a four inch trenching hoe is used to dig down a further two feet, or less, leaving at each side a ledge about three inches wide. A strip of very strong bamboo matting, twelve inches wide, is then laid along the trench, resting upon the ledges, and the soil is filled in to the surface. This system ensures that there are no open drains on the surface, while there is an underground channel two feet deep and four to six inches in width.

The objection to the system is that in the course of a very few years the mat underground gives way and the whole drain enters upon a state of collapse. This is recognised by the authors of the scheme, and is provided for by the plan to dig a new drain in the adjoining line each year ; so that assuming that the original drains are dug in every tenth line the whole

area of the property will be treated in the course of ten years, and the first drains can be re-opened and the treatment repeated. The scheme is excellent, as it combines what is known as "trench digging," which is perfect cultivation, together with very effective drainage. An important point to bear in mind in adopting such methods is that in returning the soil during filling in, the surface soil should be again on the surface, in its former position.

Underground pipe drains have not hitherto found favour on tea estates, partly on account of the expense, and also because the open trench drains do not seriously hinder cultivation on a tea garden, as at present carried out by hand. It is different from general farming, where the lands must be ploughed at intervals, in which circumstances open drains are impossible. The difficulty of obtaining drain pipes for tea estates at anything like a reasonable cost has ruled them out. Recently, however, the development of suitable machinery has rendered it probable that very soon the estates which are identified with the best systems of management will find it to their advantage to adopt pipe drainage on a considerable scale. The invention of machines for making pipes of concrete material at a moderate price has made it possible for any estate of considerable size to have its own machine for making pipes, either of clay or concrete, according to the materials available.

Pipe machines.

Usually subsoil drainage cannot be attempted on hill-gardens, except on some slopes where the formation of the ground tends to hold rain-water and spring-water in a stagnant condition, and on many estates there are some portions like this. The land in such places, although somewhat sloping, is water-logged, and the tea plants languish in consequence. In such circumstances a few deep drains

Hill drainage.

act like magic. The general idea in hill drainage is of necessity to get rid of *excess* water as rapidly and satisfactorily as possible. It is impossible to make any considerable proportion of the rain percolate through the soil during very wet weather, as the enormous weight of water is so apt to burst out or gather way at some unexpected spot, causing landslips, watercourses, and general devastation. Surface drains are necessary at portions of the hill-sides where water would naturally collect and gather way, and they have to be made at an angle across hill following the contour in such a way that the run will not be too steep.

Contour drains.

It is of the greatest importance that all drains should be carried to a suitable outlet; more damage has been caused by misdirected drainage and by blocked drains than is generally understood. One of the most important of the routine duties on a hill-garden is to see that all drains are kept free of rubbish or anything which might get collected in any one place and so cause a block, especially at times when heavy showers of rain may be expected.

Outlets.

On some gardens an elaborate system of drains is adopted; the drains running at intervals across hill with catchpits at suitable distances for gathering silt, these being periodically cleaned out and the silt carried back to the land. The idea is excellent, but has not yet been adopted to any extent on the hill plantations of India.

In respect to the benefits derived from rainfall, all hill-gardens are at a serious disadvantage, because it is impossible in the nature of things for the great body of the rain to soak *through* the soil; much of it must run off the surface of the ground into streams, carrying all its valuable manurial properties with it, and sometimes a good deal more besides.

According to the tenets of agricultural science, all rain-water should be made to pass through the soil; but on steep land this is impossible after the soil has reached saturation, because subsoil drainage cannot act rapidly enough to keep pace with heavy rain falling upon the surface. Some of the water must of necessity flow off into surface drains or streams. The theory that a cultivated surface has the best chance to prevent loss of soil by wash, applies only up to the point of soil saturation.

Saturation.

It may be noted that when soil has become very dry, rain finds at first great difficulty in penetrating it, even if thoroughly pulverized. This can be verified at any time by placing perfectly dry soil in a flower pot loosely and then pouring water upon it. It is remarkable how long the water will lie upon the surface in a pool before beginning to disappear. This points to the advisability of allowing a light growth of weeds to grow upon the land just before the advent of the monsoon rains.

The whole subject of drainage is treated in full detail in the book just out, entitled "Drainage for Plantations," published by Thacker, Spink & Co., Calcutta; obtainable also from Thacker & Co., London.

CHAPTER III.

PRUNING.

In its natural state in the forest the tea shrub grows to a height of from 15 to 30 feet or more, a height and an extent of foliage which unfits it for the rapid production of leaves in successive "flushes," while its shape, as well as height, would render the labour of gathering

Reasons.

the leaves both difficult and expensive. Hence the primary object of pruning is to change the form which the plant would naturally take, and so turn it into a low bush instead of a tree.

The next object is to encourage the bush to produce leaves rather than wood, and to spread into a ramification of twigs, giving a large plucking surface, and yet not so dense as to obstruct the free passage of air to the leaves everywhere, which is a condition essential to the healthy life of the plant. (See "Functions of Leaves.")

As the plant matures and ages, it becomes necessary to remove dead and moribund branches, and to thin out unproductive shoots where growth has become too dense. It becomes also necessary in course of time to cut out knotted or bark-bound branches, which hinder the free flow of sap to the leaves.

In all questions of pruning, as well as other operations, the continued robust health of the plant must be reckoned as of primary importance, and when properly done, pruning is a distinct aid rather than a hindrance to health. It has been observed, for instance, that in the case of tea plants grown for ornament those which were pruned occasionally kept in better health than others, which were allowed to grow naturally.

Frequency.

The frequency of pruning depends to some extent upon circumstances, and experience has proved that in forcing climates, where a large yield is obtained, the best results are obtained by pruning once a year. In Ceylon, where there is no winter or season of rest, some of the best authorities, while recommending an annual pruning for tea at low elevations, prefer to leave hill-gardens unpruned for two or even three years, if at a high altitude.

In North India the practice generally has been to prune the whole estate annually, during the season of plant inactivity. On hill gardens also, this has almost invariably been the custom in past years. Of late, however, opinions on this subject have become greatly modified, and some of the best authorities are now inclined to think that an annual pruning is in some instances too frequent. For estates at an elevation over 4,000 feet it is distinctly advantageous to leave one-fourth, or even one-half, of the area unpruned each year.

Unpruned tea.

One or two gardens in Darjeeling District have adopted a system of pruning only once every three years with very encouraging results. Only one-third of the whole area is pruned each year in turn. Under this system the largest crop is obtained in the third year after pruning, and the average crop per acre for the whole estate, also the price per pound, compares favourably with that of the best estates in the district of Darjeeling. The stipulated general proviso is liberal treatment of the bushes throughout the growing season. When the three years have expired the pruning necessary is a kind of beech kallam, as the growth of wood has become so thick.

There are certain important considerations in leaving part of the estate unpruned. It is a great saving of labour and expense. The unpruned bushes yield smaller

leaf and better tea. The flushes come earlier, and so modify the rush at the busy season. The dense shade caused by the upper growth suppresses and kills off small unproductive twigs within the bush, so that when pruned the succeeding year the bush is found to be sufficiently open, and no expense is required for thinning out in pruning. The shade also kills off moss in a most remarkable way. The one objection is that when such bushes are pruned in the second year, the new growth takes a long time to start away; this is compensated for, however, by a much more vigorous growth when it does begin, as the wood of the bushes is so much stronger than before.

Skiff pruning.

Some planters are of opinion that the unpruned bushes should have just a little cut off the tops of all the shoots, whether the bushes be high or low, weak or strong. This has come to be known as "skiff pruning." It does not appear that there is any advantage in doing all this, unless in cases where the growth upon the bushes is very irregular, with isolated shoots run out considerably above the general level of the bushes. This is frequently the case with fine jat bushes. It is difficult to get coolies to use proper discrimination in trimming them; but a good workable plan is to arrange for skiff pruning to a certain height from the ground, say three feet, for instance; each cooly then has a measuring rod, and all the growth above the measure is slashed off, the low weak bushes remaining untouched.

Task work can be arranged by measurement of the ground covered; a definite number of nulls or tangas, instead of a number of bushes pruned.

Side pruning.

It is often desirable to side prune bushes in a block which is left unpruned or skiffed, especially when they have been so wide as to be interlacing. It is a good rule in such cases to side

prune so as to make a space of 12 or 15 inches between the lines of bushes.

It should be clearly understood that leaving unpruned is recommended only on the understanding that in the plucking season the bushes are to be treated in the same manner as the rest of the estate. If close plucking is resorted to at the beginning of the season, because the bushes were not pruned, the result is hardly likely to be satisfactory.

Finger pruning.

The plucking of leaf may be described as a kind of finger pruning, and some people hold a theory that if this work is done with sufficient care and exactness, the operation of pruning with the knife may be deferred for an indefinite period This idea is worth considering and is said to have been acted upon in one of the driest tea districts of India with some success. It has been found that, as a rule, bushes which are never pruned become practically unproductive after a few years.

Season.

The time for pruning must always be when the sap is said to be down and the plant is in an inactive state. Probably the best time is about Christmas to the end of December or middle of January. The amount of work to be done, however, and the short labour force available, usually makes it necessary to begin earlier and go on later than this.

Implements.

For very careful light pruning the peach-pruning knife is best ; but this knife is not suited for rapid work or for cutting heavy wood, hence the most useful knife for all-round work is that with a slightly hooked or curved point and about eight inches long, including handle. For heavy pruning a large, heavy hooked knife is required, measuring about twelve inches long, eight inches of handle, and only four inches of blade ; merely a large hook. All knives should be of the very best steel obtainable, and the edge

kept continually sharp and keen. In this matter it is exceedingly foolish to attempt petty economy, because if the cooly works with a blunt knife, the prunings will be torn off instead of being cut, while the amount of work done in the day will be much less than with a sharp implement.

Age for pruning.

The age at which pruning should commence has been much discussed. Some people think it desirable to let the plant grow for two or three years and attain a height of six feet or more before pruning, the theory being that no check should be given to its development until the plant has become big and strong. The chief objection to this is that, especially with high class plants, there is a natural tendency to grow a long clean stem, and after this has been formed, there is very great difficulty in forcing the plant to throw out branches anywhere near the ground, so as to become bushy, and the shock of successive severe prunings in order to accomplish this is much greater than if the operation had been performed when the plant was quite young and succulent, and when the bark of the stem still contained the eyes in embryo, from which new branches could be developed; hence it is much better to prune when quite young, sometimes even so young as six months or one year.

Effect on roots.

Pruning has a direct effect upon root growth; hence, if it is done at the proper season it is of the nature of a stimulant, encouraging the roots to throw out new branches, and so it becomes a benefit rather than a hindrance to the development of the plant both above and below ground.

As soon as the young plant has got a good hold of the ground, say, eighteen months after planting, the knife is to be applied. In some instances it can be done six months after planting, or in other cases it must be deferred for an extra year, but in any case it should be whenever

the plant has established itself and made good health) growth.

Height.

At the first pruning it is best to go well down especially for the centre stem, whicl may be cut to as low as nine inches o1 even six inches from the ground, provided always tha1 there are one or two side branches existing below this The side branches may be snipped off at about fifteen o1 eighteen inches from the ground. The wounds should b(slightly slanting.

Effects of pruning.

The object of this pruning is to divert the sap, whicl would flow up the centre stem, into th(side branches, to develop these, and als(form new ones continuously spreading outwards. Th(natural tendency of the plant is to throw greatest growtl up the centre ; hence our object is to cut the centre almos completely away and so distribute the sap in an even flov to all parts of the bush which is being formed.

The most experienced and successful planters hav(gradually come to the conclusion that a tea bush witl a clean stem and shaped like a champagne glass i: undesirable. The lower the branches are formed th(better, and all should, if possible, be covered to som(extent with light twigs and leaves, which form a protec tion from sun and wind.

Second pruning.

The second pruning should be to a height of abou 15 or 18 inches, and the plant: may be cut straight across. Th(succeeding pruning should be similar, but two inches or s(above the previous cut. Sometimes in the second o1 third pruning, bushes have been cut somewhat in th(form of a saucer, with a depression in the centre, th(object being still to suppress excessive growth at tha1 part, and divert the energies or growing powers of th(bush towards the sides. This is an excellent plan

although it involves more difficulty in the following year when pruning to a level surface.

Necessity for system.

The idea of pruning every individual bush according to its requirements is good in theory, but is workable only to a very partial extent. After the bushes have been fairly formed up and cropping has begun, it is necessary to adopt some definite system of pruning for each block. No gang of coolies can be expected to work with sufficient discrimination to cut some bushes lightly, some medium, some heavy, and some not at all within the same block, as required. Even if such discrimination and judgment were possible in the ordinary cooly with regard to pruning, all the good effects would be lost by the resulting confusion in the plucking season—because each style of pruning requires that a different system of plucking be adopted, at least during the early flushes. However desirable it may be to treat one bush differently from another, it is necessary to adopt a style of pruning which will be generally suitable to the bushes throughout any one block for that particular year. Several styles of pruning may, of course, be carried out at the same time, but each should be carried out in a separate block or portion of the estate. Some modifications of this rule are sometimes necessary, as in the case of young infillings or of very weak bushes.

Young wood elongates.

Although the second pruning is done by measure, so that all the bushes are of exactly the same height, it will be found, before many years, that the height has become very unequal, especially on a hill-garden, where there are great differences in the character and richness of the soil, even within quite a small area. The reason for this is that all young sappy wood elongates more or less for several years after pruning, and the wound, which at the time of cutting, was 18 inches from the ground may, in the course of a few years, be 19 inches or 24 inches, as

the case may be, according to the vigour of the particular bush and the richness or poverty of the soil in which it is growing.

For the reasons given above, our bushes, after being formed, must be expected to be more or less uneven in height, but a good rule for ordinary pruning is to cut straight across, leaving one eye of new wood above the previous year's cutting. If the previous pruning has been well done, and the plucking has not been severe, such a system of pruning will be simple, easy, and comparatively inexpensive.

Ordinary pruning.

All rough haphazard pruning or slashing at the bushes is to be avoided, and mere cheap pruning (because of its cheapness) is the worst possible economy. The time has gone past when much labour was expended on a very small area, and each twig was handled and examined before the knife was applied, but the tendency in these days is too much in the opposite direction, the one and only question now being how many bushes on an average are cut by each cooly per day, or how cheaply per acre can the work be done. One result of this is that in many instances the work of pruning is mere meaningless mutilation, while even on some of the best-managed estates a policy of "beech kallam" or of more or less heavy pruning is adopted, simply and solely because in that kind of work the coolies can get through more bushes per day. In this respect, perhaps, managing agents are sometimes to blame when they press the question of the cost of pruning per acre without due reference to the quality of the work done or the condition of the bushes on the estate.

Cheap pruning.

There are some gardens where the bushes have been worked down to such a state that they more than anything resemble mere stunted cabbages. The pruning of such an estate is, or ought to be, in any case, a very cheap affair indeed. Pruning is done but once a year at the

best, and its effects upon the succeeding crops are of much greater importance than seems to be generally realized.

Unpruned tea. Stripping. If the labour staff is seriously short, it is better to prune only a portion of the garden properly and carefully, leaving the rest to be done the following year, rather than do all in a very rough way.

By thoroughly good pruning we do not mean elaborate thinning out or stripping the stems. Such work is doubtful policy at all times, and in many circumstances it is positively disastrous. Of course, it *looks* neat and pretty to see the bushes very much thinned out with the stems clean and leafless; such bushes begin to flush early, and everything for a time looks very promising. Appearances are misleading, however, the early flushing is caused by the bushes making a desperate effort to cover themselves with sufficient foliage to breathe by, but on the whole, the shock resulting from the stripping has been too great and the yield for the season will almost certainly be disappointing. This will **White ants.** be worse if the garden suffers from a drought in spring, or if the treatment during the first flush is otherwise than generous. Clean pruning, by causing the stems to get dried up, is a direct encouragement to white ants.

In pruning, the cooly should go round the bush pruning from the centre outwards leaving, in ordinary pruning, one or two new eyes, as the case may be. If **Pencil wood.** there is good pencil wood to prune on, this will be a very simple operation, and even if the growth to be cut off is considerable, the operator will soon learn to take enough at the first cutting without having to go over the bush a second time. This is one of the points which the Assistant and the Overseers must aim at teaching as soon as possible, as it saves a vast amount of the cooly's time. The Manager and his

assistants will continually examine the bushes recently pruned, in order to be sure—

1. That the requisite amount of new pencil wood has been left—not too much.

2. That no shoots have been cut too deeply or back to the old wounds.

3. That the cutting has been clean, not a tear or fracture.

That the stems have not been split by pulling over the piece to be cut off when applying the knife.

5. That there are no long wounds or gashes on the stems or branches.

Thinning.

Whenever the bushes have got dense on the surface a little thinning out is necessary, in order to allow a passage of light and air. This is to be done by taking out twigs or creeper-like trailers from the denser parts of the bush, taking care to cut so as to leave no stumps. No stripping of mere leaves should be allowed, and the thinning should not be carried to excess. Open parts of the bush are to be left untouched. In no case must the knife be allowed down into the centre of the bush, or any good branches be cut away. If a cooly is set to thin out a dense bush, he soon finds that the easiest way is to cut out a few *branches*, and so, if permitted, he permanently spoils the framework of the bush itself.

Crow's feet.

In some instances, especially if close plucking has been the rule, there will be more or less of snags or "crow's feet" on the surface of the bush; these need not in every instance be cut out, but may be carefully divided with the knife, the portion left being as clean and straight as possible.

It must always be borne in mind that if bushes have been well grown in the plucking season, especially at the beginning, very little need be done at the pruning season in the way of thinning out or of cutting out snags, because

the growth will be healthy, and neither dense nor scrubby. This rule applies to all classes of plants, but more especially to fine hybrids and indigenous. Very dense bushes tend to produce " banjy " leaf, while very open bushes tend to watery poor tea.

Trailers.

Trailing branches are a source of continual trouble and damage to the plant. The pluckers tread upon them, the cultivators bang them about, the sicklers hack them, and eventually they get torn away from the stem, leaving a very deep, ugly wound on the most important part of the bush. Trailing branches need not be cut completely away at the neck, but should be shortened back to about half their length, care being taken that the cooly cuts upwards, leaving the wound on the *lower* side of the branch ; the stump of the branch will then throw a new shoot straight upwards, and what was before a source of weakness and injury to the bush will become an addition of strength and usefulness.

Sugar-loaf shape.

While the more usual form of bush is that with a flat surface, some planters, whose opinions deserve great weight, prefer the sugar loaf shape, which involves a certain amount of side pruning and plucking. This shape of bush is certainly more like the form which it naturally takes when left to itself, but the great objection is that the sap goes too much to the centre of the bush, where it should be checked rather than encouraged. Side pruning becomes a necessity when the bushes have grown to such a size as to be interlacing with each other.

Side pruning.

It has been found a good plan to do the side pruning by a special gang of coolies who are each given a measure, 12 inches or more, as the measure of the clear space which must be cut away between the lines of bushes. The method of

cutting being similar to that described above for cutting trailers.

Weak bushes. In all cases weak bushes require to h ve special treatment. In their weak state they produce next to nothing, and it is imperative that they should either be renovated or removed, otherwise they are mere cumberers of the ground. The removal would be a very doubtful policy, because any other plant put in its place would itself have to pass through a season of weakness before becoming fully established. The only way to give a weak bush a chance is to keep the hands off it in the plucking season. No cropping may be done beyond mere finger pruning of the very long shoots, as mentioned elsewhere. It is a mistake to prune such bushes high ; better not prune at all until they gather some strength, then cut well down, sparing them again, as before, in the cropping season.

It may be here remarked that pruning, when done at the proper time, is not so much of a shock to the plant as a succession of pluckings in the growing season.

Infillings. Young plants filled into a block of old tea require to be treated more generously than in a new extension. They have to contend with the old bushes, whose roots already occupy the ground, and which have selected and appropriated more or less the best and richest corners ; hence the young one has a struggle for existence during the first few years, and it must be allowed every possible assistance. It is better not to prune or pluck these plants until they have grown well, then prune well down, especially in the centre, to about 12 inches, sparing them again in the cropping season.

Size of bushes. The size of the mature bush is a subject of much controversy ; many people have the impression that very large bushes are

not favourable to the production of good tea: others again cling tenaciously to the idea that high bushes are essential. In this matter a medium course is probably best; bushes with a moderate height and a good spread, no doubt, give the best result, both in quantity and quality. From two feet to two and a half feet is probably the best height for bushes of a good class; anything higher than this is too lanky, the stems or main branches become too much exposed to sun and wind, which bakes the bark and renders the wood dry and hard, retarding the free flow of sap. High bushes are difficult to pluck, especially for children, the more so as the season advances and green growth is added to the height after pruning, such growth being sometimes as much as two feet or more by the month of October. The natural consequence is that the smaller coolies, when plucking, climb upon the branches and so do more or less of permanent damage.

Heavy pruning.

As the line of pruning each year is slightly above the line of the previous year, the bushes gradually increase in height, so that the time comes when it is necessary to prune back to some previous point and begin over again, or perhaps to prune more heavily and lower than ever before.

There are other questions, as well as mere height, which determine the necessity for heavy pruning. Each year after the ordinary pruning, the shoots have to start from new eyes, and the snag resulting from pruning forms more or less of an obstruction to the upward flow of sap. This goes on year after year, and even under the most favourable circumstances the stems which are thus built up must of necessity form very erratic and inefficient channels. Hence it becomes advisable, at certain intervals, to go well down, sweeping away the portions which have become inefficient, and then grow new clean branches or stems in their place. Fortunately a healthy tea-bush is capable of producing

Snags.

new limbs, but it is highly desirable that the operation of removing the old ones should be performed in such a way as to give the smallest possible shock in the circumstances. The pruning of a tea-bush, year by year, tends to accustom it to the treatment; so that when heavy pruning has to be resorted to it responds readily, provided always that it is in good health. One thing must be noted, however; every time such pruning is resorted to, one or more snags of a serious kind are formed, and to that extent the framework is rendered faulty; hence it is an operation which must not be often repeated. This all goes to show that severe pruning should only be resorted to when absolutely necessary. In practice it has sometimes been found that when a block of rather weak tea is subjected to heavy pruning a few of the bushes fail to survive the operation. Several devices have been suggested to meet this difficulty. One is that of leaving one branch uncut, standing up alone, to ensure that there shall not be a stoppage of sap circulation. A few planters advocate pruning out only half of the branches one year, and cutting away the remainder only after new branches have formed up. These are very doubtful devices, and have not proved generally satisfactory. When cutting

Latent eyes.

thick wood, it is not easy to discover the position of latent eyes; if possible, however, the wound made by cutting should terminate just about a quarter of an inch above an eye, the wound being at an angle of 45 degrees on the opposite side from the eye. If the branch is healthy, it can develop sprouts at almost any point; sometimes quite a cluster of sprouts bursts away at more than one point near the extremity of a heavily-pruned branch. If the bush is weak, there is a great tendency for the branch to die back several inches; this forms a very serious snag; the decaying stump harbours white-ants and other pests, causing a canker which may eat into the vitals of the bush. There

is less tendency to die back if the pruning is done so as to form a fork than there is with straight wood.

The bush is a living thing which demands some consideration; it is not to be treated with saw and axe merely as a carpenter treats a log of wood.

As an immediate result of severe pruning, the bush is stirred up to a desperate effort; firstly, to throw out new limbs to take the place of those which have disappeared; secondly, to produce new bark at the points of section, and so heal over the wounds which have been made. If the cutting has been of a rough or thoughtless kind, these efforts will be to a large extent frustrated. The chief aims of the planter are to make the wound in such a way that it can be most readily healed over, and to do anything possible to aid in the process of healing.

Healing.

The first hindrance to healing comes from the drying and warping influence of direct sunshine. Everyone who has had any experience of budding and grafting fruit trees knows how important it is to protect the wounds from the influence of weather. The direct rays of the sun, beating upon any wound or incision in the bark, tend to make the bark warp and curl away from the wood; hence it is usually bound tightly with a bandage of some sort, or the wound is smeared over with grafting wax. When the operation is properly performed, the plant soon begins to form new bark, which gradually pushes its way under the wax until the space is joined up, and in course of time all outward traces of the wound disappear. Immediately after heavy pruning, it is very desirable that the wounds should be smeared over with some sort of covering in order to shield them from the scorching rays of the sun, and from the possible attacks of insect pests. Many planters use tar for this purpose; it is the most convenient thing, but is not quite so effective as grafting wax which is soft enough to

Tar.

allow the new bark to push its way underneath and yet tough enough to resist the onslaught of rain.

Heavy pruning should not be lower than is necessary the first time, so that at subsequent heavy cuttings it may be possible to prune away all former snags and then grow clean new stems.

In many instances heavy pruning has been undertaken and carried out in circumstances, and with previous and subsequent treatment, which all go to show that the work has been taken in hand in rather a light-hearted manner, and with very little knowledge or study of the questions involved—the advisability of doing it at all, the manner of doing it, and its general effects on the health and life of the plant. In regard to this matter it is not too much to say that in some instances the treatment which the estates have undergone has been simply atrocious, and hence it is little wonder that some people have contracted a dread of heavy pruning under any form, and in any circumstances. The worst part of the treatment, however, has usually been not the pruning itself, but the system of previous and subsequent cropping.

Need for heavy pruning.

When bushes have become too high or unshapely with stems and branches exposed to the baking influence of the sun, or when many years of pruning have resulted in a series of stems which consist of a succession of knots and snags retarding the flow of sap towards the extremities, then the need for heavy pruning is indicated. In this connection it must be noted that heavy pruning is no cure for mere weakness, and at best it can only be looked upon as perhaps giving an opportunity for the sparing and growing, which in such cases is necessary for a return to health.

Weakness.

The immediate effect of heavy pruning is a reduction of crop for that year, this amounting to a loss of as much as half the crop for the

Effects on crop.

season, and on hill-gardens a loss of two-thirds or even three-fourths. This loss is accentuated by the fact that what tea is produced in the year of heavy pruning is of exceedingly poor quality : the leaf is coarse in texture, the outturn dark, and the liquor either very weak or very distasteful. These considerations are, of course, very important indeed, and are alone sufficient to allow for heavy pruning being described as a " *heroic remedy.*"

When this treatment has been decided upon for any particular block of tea, it is customary to pluck that block very hard or close during the season preceding the operation. Nothing could be more unreasonable or injudicious. When a surgeon contemplates the performance of a severe operation, he directs that the patient must have absolute rest and the most nourishing food for many days before, by way of preparation for the shock, and yet our poor tea-bush is to be subjected to more cruel treatment than ever by way of preparation for a shock which involves the partial or complete amputation of all its upper members. The circumstances of the case require that in the previous season the cropping should be, at most, not heavier than usual. In this case the roots will not be debilitated by the severe strain involved in close cropping, and they will be ready to exert themselves to the utmost during the coming struggle for the breath of life. For the same reason the cultivation and general treatment should be liberal before, as well as after, heavy pruning. It has been observed that sometimes bushes have got into such a weakened condition before this operation, that the pruning actually throws them into a state of insensibility for many months ; a block of tea of this sort has been known to have fifteen or twenty per cent. of its plants absolutely without leaf or bud or other sign of life for six months after pruning, and while a

Close cropping.

Preparation for heavy pruning.

Insensibility.

considerable number of these expire altogether, the remainder have been only able to send out a few feeble shoots towards the end of the growing season. Very weak tea should be well manured a year before heavy pruning.

"Beech kallam."

It is not often that half heavy pruning or "beech kallam" is advisable or likely to prove satisfactory, unless in the case of old tea which has already been heavy pruned. When severe wounds have been made, it is absolutely necessary to leave the bush to grow well for some time before cropping, hence the loss of crop will be nearly as great as in ordinary heavy pruning, while the general improvement to the framework of the bush is not great. If the crust is to be broken at all, the best plan is to go well down, taking care, however, to preserve as much as possible of the principal branches and framework. The work must be treated as *pruning*, not mere "*hacking down*," as it has often been described. Cut down to about 12 inches or 16 inches from the ground. None of the inside twigs or leaves should be cut away, but trailing branches should be trimmed back as described already. The side branches are to be retained as far as possible. A very important point is to preserve the width of the bush while reducing its height.

Hacking down.

All cutting should be from the centre outwards; thick wood all to be cut with a saw, and the wound cleaned with a knife afterwards. No hacking should be allowed under any circumstances. A good plan is to make the coolies go in couples, one with a saw and one with a knife, especially if there is much heavy wood to be got through.

Tar.
Grafting wax.

In places where the white-ant is to be dreaded, all heavy wounds should be smeared with tar, or, what is still better, with grafting

wax, a mixture of bees'-wax, rosin, and tallow in equal parts.

Moss. Immediately after heavy pruning, a special gang of coolies should go round scraping off carefully all moss, lichen, etc., from the remaining branches. After the branches have been scraped they may be treated with a strong solution of Soda Ash, which kills parasites and promotes healthy growth of clean bark. This is to be done without delay before there is any possibility of new buds having begun to sprout.

Collar pruning. Collar pruning, as formerly practised, meant cutting the framework of the bush completely away, leaving only the collar standing to a height of six or eight inches above ground; this, however, was found to be in practice very unsatisfactory, chiefly because of the difficulty of healing the wound, and in many cases white-ants got into the wood before the wound could get covered over with new bark, and when once they obtained a lodgment, their operations gradually resulted in the complete destruction of the plant. A cure for this state of things was discovered by a certain Assam planter; instead of leaving a collar of six inches above ground, he cut right under the surface and hard on to the spread of the roots. The results of this style of pruning were all that could be desired, and the example has now been very widely followed. It is wonderful how soon new sprouts come away from the roots, and a new bark grows over the wound itself. There are several points which demand attention in carrying out this work; the cutting must be done with the saw after scraping away the necessary amount of earth; a two-handed saw has been found very effective for this; the wound must be scraped clean with a knife and smeared with tar or wax, and the subsequent cultivation must be very carefully done until the new

shoots have become fully established and formed into strong branches. For scraping the wounds, a spoke sheave is very suitable.

Notching.

In order to obviate the danger of bushes dying out under the operation of collar pruning, a device has been adopted of notching the stem one year previous to the main operation. The notching consists in cutting the stem from one side, half way through, so causing a barrier to the upward and downward flow of sap on that side, and encouraging the bush to send up one or two adventitious branches direct from the base ; so that in the succeeding pruning season when the stem is cut clean through at the notch there will be one or two new branches to keep the bush going and to start it upon a new career. The theory has much to recommend it ; but has not yet been put to a sufficiently practical test. In case a bush fails to burst away into growth from below the notch the net result is that the bush is weaker than before, and less able to survive the collar pruning.

Caution.

It is quite a mistake to look upon collar pruning as a cure for all the ills to which a tea-bush is liable. It must be clearly understood that this treatment is recommended as something in the nature of a last resource, and it should on no account be adopted on comparatively young gardens, or with bushes whose framework will still stand an ordinary heavy pruning. In the nature of things, it is an operation which will not bear repeating. As a preparation for collar pruning, a liberal dressing of manure should be given in the previous year, supplemented by careful and good cultivation.

Subsequent treatment.

After heavy pruning, it is very desirable that the whole area should have a thorough top dressing with new soil, or at least a good dressing with manure. The first result of the

pruning will be increased activity on the part of the roots, if our plants are in anything like a healthy state, and it is highly necessary to provide a supply of good nourishment for the special occasion. Every possible aid must also be given in the direction of careful and thorough cultivation, so that the bushes may have every chance to establish themselves more firmly and healthily than ever.

On the after-treatment of a block of heavily pruned tea a great deal depends, more indeed than is generally supposed. No one with any sense nowadays will think of cropping until growth has reached a sufficient height, but it is too commonly supposed that, after a certain height has been attained, all special treatment may be dispensed with. The course of treatment should extend to at least two years further, in order that the best results may be obtained.

Height after pruning.

If growth has been very robust during the first year, the plants will be simply cut across at the most suitable height, which may be about 18 inches; or if the climate is very forcing, it may be even lower than this. In any case, at least two eyes of new wood should be left above the highest of the old wounds, the rest of the bush being cut straight across to that measure.

Sloping bushes.

On hill gardens, if the bushes are large and the ground steep, they should not be cut level, but should be *sloping* more or less in the direction of the ground; this is very important, because subsequent prunings are to be on this model, and if the lower sides of large bushes are on a level with the upper side, they will soon be too high for pluckers to reach conveniently, and much leaf will continually be abandoned on the very bushes which should be most fully cropped.

If at the end of the first year after heavy pruning it is found that the wood grown has not sufficiently ripened or is too lanky and sprawly, the treatment above referred to must be deferred for another year, and meanwhile they can be just cut across at such a height that the green tips will be removed, and they can be pruned down to the proper level at the end of the second year. In special cases the bushes can be left altogether unpruned.

Pruning high.

Leaving these bushes high does not mean that they may be cropped closely during the succeeding season; the conditions all point to the reverse of this, and in any case there must be good growth put on at the beginning of the season.

Some planters adopt a system of severe plucking after having spared the bushes during the first year. The bushes are pruned rather high, then closely plucked; then they are pruned *below* the previous year's cutting; with similar treatment year by year, going down lower and lower, until something like collar-pruning has to be adopted, with one year's rest followed by high pruning again. A glance at this system will show that in its nature it must be exceedingly severe upon the health of the bushes, and must soon reduce both their root power and vitality.

Pruning down.

The greatest mistake in modern tea-planting is in plucking *closely* during the second and succeeding years after heavy pruning; thus turning what should mean a new lease of life and vigour into a condition of permanent weakness, ending in disappointment and not seldom in disaster.

Close plucking.

When the bushes are cut straight across the first or second year after heavy pruning, they will be found to be more or less densely filled with leaves all the way up from the ground, giving the impression that a good thinning

out would be very beneficial; hence some planters make their coolies strip off all these twigs and leaves, leaving a set of beautifully clean stems with a few leaves at the top. Experience has proved that this is a terrible mistake which may never be properly rectified. The stems, being exposed to the sun, very soon get baked and hard, retarding the free flow of sap; then they get covered with lichen and moss, resulting in a worse condition of things than before heavy pruning.

Stripping.

As before mentioned, heavy pruning is only to be undertaken when circumstances render it necessary, but when properly done, the results may be highly satisfactory.

In some instances, where separate records of heavily-pruned blocks have been kept, the crops of fine leaf produced in subsequent years have been quite phenomenal, and the general health of the bushes greatly better than before.

As in other departments of work, it is very desirable that coolies at pruning should be given something like a task. The only question which keeps some managers from giving a task is that it usually means bad work, and this particular class of work demands more care than perhaps any other. The question of economy, however, is of great importance in these days, and as coolies will not do their utmost without some sort of incentive, it is worth considering whether they should not get some sort of task, and either be allowed to go home when it is done, or get extra payment for working on. With work of this sort, it is very desirable that coolies should not go away until the usual hour for leaving at the end of the full day. This ensures more care and gives full opportunity for the overseers to examine as well as control the work done; hence the plan of giving payment for extra work is the more satisfactory and it is especially

Task work.

Extra pay.

so where the labour staff is rather short. A plan which has worked very well is to give men's wages to all women who prune more than a certain number of bushes each day, the task being altered from time to time as necessary, and the men being engaged at work other than pruning or at special pruning at which a task cannot be fixed. Anything like double pay or excessively high inducements carries us beyond the region of economy and must make the work unnecessarily expensive.

CHAPTER IV.

New Gardens or Extensions.

Selection of land.

It is of the first importance that the land selected for planting with tea should be of the best quality obtainable. It is a truism that 500 acres of really first-class land are worth more for tea planting than 2,000 acres of indifferent or even of medium quality.

The planting of a piece of land with tea should not be lightly undertaken. It is not a crop to be grown one year and abandoned the next if the conditions prove unsuitable.

The selection has far-reaching results, and once made, it is to be adhered to for generations to come; otherwise it means that a large sum of money is literally thrown away.

Quality of soil.

The first consideration, then, in selecting a site for a tea garden is that the soil must be rich enough, and deep enough to stand the mechanical and chemical strain of being continuously cultivated and cropped for at least one hundred years, without necessarily any addition of manure.

Any rich soil, whether light or heavy, will suit for tea, provided it receives proper treatment. In practice, it has been found that the most flavoury teas have been produced from soil of chocolate colour, or a mixture of red clay with a large proportion of organic matter.

Virgin soil.

Virgin soil is, of course, very much to be preferred. Any land which has been under cultivation for a great many years should be avoided, unless it is manifestly a naturally rich soil.

A slovenly system.

When making extensions, many planters have adopted a slovenly system which cannot be too severely condemned. A piece of jungle land is selected for opening out, and it is deliberately given over to coolies to cultivate on their own account for one or two years, so that when the manager comes to plant his tea, the preparation of the ground may be easy and cheap. Meanwhile, however, the soil has been greatly impoverished by exhausting crops—*three* or perhaps even *four* in a year—and the rich vegetable mould which should have formed the milk diet for young tea-plants has been largely used up in the production of 500 per cent. profits for the cooly.

Sodden land.

Land which is sodden with water, or liable to become so, should not be selected, unless a thoroughly efficient system of drainage is possible. Sour stiff clay, which has been used as rice-fields, is quite unsuitable for tea, and the attempt to plant such only ends in utter disappointment. Any land, however rich and desirable, which from its situation might possibly at some time become devastated by a neighbouring river breaking over its banks, or changing its course, should be left severely alone. There are many instances of fine young plantations having been within a few hours utterly ruined by such a catastrophe.

Light soils.

Light friable soils grow tea very well, but only if there is a sufficient rainfall, *well distributed.* In a climate which is subject to long droughts of, say, five to seven months with practically no rain, stiff soils will stand the strain best provided the cultivation is thorough.

Climate and rainfall.

The rainfall necessary for tea is from 60 to 200 inches annually, but the average for the existing tea districts is probably between 70 and 100 inches.

The best conditions exist when this rain is distributed over the whole year, with the heaviest showers during the hottest weather.

Frost and snow.

Moderate frost and snow have no ill effects upon tea, which, although evergreen, is practically dormant during the winter season. Frost has a beneficial effect in killing off the eggs or grubs of insect pests, and it has been noted that gardens at high altitudes are comparatively free from such attacks. On the other hand, tea at high altitudes is more liable to get loaded with mosses, fungi, and lichen of sorts, especially if badly treated.

Effects of climate.

In the lower lying portions of Assam, Cachar, Dooars, etc., where the climate is humid and forcing, great quantities of tea are produced per acre, and, with favourable conditions, the tea produced may be very strong, but it has hitherto been found impossible to get fine flavour in those districts, unless very occasionally, when autumn has modified climatic influences or *green fly* blight has aided the tea-maker.

Fine flavoured teas are produced in the milder climate of the Darjeeling Hills and of Upper Assam ; and yet it must not be taken for granted that all the land within those districts will produce finely flavoured tea.

Quality districts.

There are localities within each of the quality districts, where whole groups of gardens almost invariably turn out fine teas at certain seasons ; and other localities, apparently similar, where fine teas are seldom or never produced.

The chief difference is no doubt in the *soil*, as well as the climate, hence the selection of the locality for planting is of supreme importance.

Forest and grass-land.

The question as to whether forest or grass-land will yield better results has often been under discussion. The former has by far the

most in its favour, although the *preparation* is much more expensive, when properly done.

Although soil is the first consideration in selecting the site for a new garden, there are several other matters which are almost if not quite as important.

Water.

There must be obtainable a plentiful supply of good drinking water for the labour force which is to live upon the estate. There must also be a sufficient supply of water for the engine and general factory use, through the dry months of the year. Some estates have been almost ruined through want of water in the hot months before the monsoon; deep wells even proving a failure, and the inhabitants consequently suffering in health by having nothing but brackish water to drink, and very little of that.

Water Power.

If the property is situated in a hilly country, where there are mountain streams, it is of importance, if possible, to fix upon a site where water power will be easily available for the factory. This means an enormous saving in the annual expenditure.

Forest.

Suitable forest, and of considerable extent, is very desirable, in order to have fuel for machinery, as well as timber for buildings and for tea-chests. The property must also be so situated that there can be rapid and cheap transit of tea from the estate, and of supplies for the labourers.

Means of transit.

Nurseries.

Having selected the land for the new clearing, the first operations are to be directed towards the preparation of nurseries. These should be made in various places where suitable plots can be found, either adjoining or within the area to be opened up: the former for preference, because a tea nursery has a wonderfully impoverishing effect upon the

ground, partly owing to the large amount of nourishment taken up by the young plants growing closely together, but chiefly from the quantity of the surface soil which is carried away with the seedlings in transplanting.

The plots selected for nurseries should be at frequent intervals and convenient distances, so that when the time comes for transplanting, the seedlings will not require to be carried far. They should also, if possible, be in comparatively shady places with water convenient.

If the subsequent transplanting is to be done by means of "ball planting" in the dry season, it is imperative that the soil of the nurseries should be entirely free of stones or gravel, and that it should be of stiff character. If the transplanting is to be done by machine in the rains, a light soil is preferable, but it must be free of stones.

CHAPTER V.

TEA SEED.

Class of seed.

THE selection of the class of seed suitable for a given climate and locality is of great importance. For a piece of rich soil in a forcing climate, with abundant rainfall, the finest *jât* will naturally be the most suitable, but where these conditions are only partially fulfilled, a plant of comparatively robust habit will be necessary according to circumstances.

In the early days of tea-planting in India, it was thought that the *Assam* variety was too coarse and quite unsuitable for making tea ; hence Government imported large quantities of seed from China and distributed it to various districts, north, south, and west, including Assam, even as late as in 1856.

Govt. Tea Estates.

The Assam Company and others in that province and Cachar were supplied with both seed and plants from the Government Tea Gardens at Kumaon which had been started with seed from China. At this time, the Superintendent of the Government Experimental Gardens, wrote as follows :—

" That the Assam plant is a marked species is true, it being distinguished by its huge membraneous and lanceolate leaf, small flower, and upright growth. It is a very inferior plant for making tea, and its leaves are therefore not used."

Assam variety.

Nowadays it is generally recognized that the opinion of that time was entirely erroneous, and, in point of fact, the pure Assam indigenous produces the finest flavoured tea.

Tea Flowers.

Fig. 2.

The leaf is very large and has a pale-green or yellowish tinge, which seems to secure for it a specially bright coppery colour in the infused outturn, and the manufactured tea has a fine flavour and aroma, peculiarly its own. These special qualities may, of course, be more or less developed by circumstances of climate or general treatment.

Munipuri variety.

The *Munipuri Indigenous* is very distinct from the Assam variety ; it also has a large leaf, but it is more oval in shape, thicker in texture and darker in colour. It produces a coarse flavoured strong tea.

Cachar variety.

The *Cachar Indigenous* is somewhat like the Munipuri, but with a dash of the Assam character in it.

The Assam plant is of a delicate nature, requiring to have very careful treatment and everything in its favour, otherwise it will become sickly and will yield a comparatively small crop. In situations where delicate flavour cannot be expected and quantity rather than quality is the object, the Munipuri plant or a hybrid of it is undoubtedly the best. This plant is much in favour for filling vacancies in Assam gardens, because of its hardy and robust nature. For gardens situated at high elevations, or in a specially dry and trying climate, a good hybrid of Assam and China, or Assam and Munipuri, is probably the most suitable. Some planters of great experience even go so far as to recommend pure China for such circumstances.

Hybrids.

China variety.

It must be remembered that China plants are not all the same, and by a careful *selection* of plants when planting out, a field of China tea can be planted, which will flush as freely as ordinary hybrid, with the advantage of a more robust habit. It must also be remembered that some of the finest hill teas ever produced in India have been from rank

China *jât*. Experience has shown, however, that, with favourable conditions as to soil and climate, a high class hybrid will produce fully as good tea, more of it, and at a smaller cost for plucking.

When the conditions as to soil or climate are not quite favourable, the safest plan is to plant a hardy class of hybrid. It might be, of course, that with special care the finest *jât* might grow and thrive, but it cannot be certain that in the future the management may be able or willing to give the special attention necessary. A very small leaf China is very objectionable ; the smallness of its leaf may give it an initial advantage in appearance when manufactured, but its disadvantages far more than counterbalance this. It yields a very small crop, does not give specially fine flavour, and is much more difficult and expensive to pluck.

Inferior China.

It has been the custom within the past forty years or more for the best estates to rear a plot of high class tea specially as a seed garden. This is usually a patch by itself in the recesses of a forest. This tea is not pruned, but is in some instances cultivated whilst being allowed to grow in its natural shape and to its natural height. Under these conditions the plant yields a large crop of seed, and being absolutely isolated from any other plot of tea and secure from hybridization, the *jât* of seed produced may be depended upon.

Seed garden.

Against these advantages must, however, be placed the facts that tea trees in such circumstances are liable to blights like the ordinary cultivation, and when blights do come they are the more difficult to grapple with because of the height and breadth of foliage. On some estates also it has been found that the trees in the seed garden after a time become sickly and even die out, partly perhaps because of their never undergoing pruning,

with its consequent renovation, and partly it may be from want of proper cultivation.

A seed garden must be planted only with selected plants from a healthy nursery.

The best authorities agree that the distance apart should be about 20 feet, triangular.

Pruning.

The practice hitherto in most instances has been to allow seed trees to grow naturally without any pruning or training; but this is now held to be a mistake. The plants should be pruned at quite an early stage, and the process repeated again at intervals until a bushy tree has been evolved, measuring about 15 feet in diameter, and 12 feet in height. After the tree has attained maturity it is to be pruned occasionally, as necessary, the general principles being similar to those which obtain regarding the pruning of most fruit trees: to keep the centre sufficiently open for the admission of sunlight: also to keep up the health of the tree by cultivation. If any manurial stimulant is required, it should contain a preponderance of potash; probably a moderate dressing of Nitrate of Potash, supplemented with Wood Ash, and Basic Slag.

Selection.

The chief objection to a separate seed garden is that it affords no opportunity for selection at time of gathering. This subject of *selection* has been brought into prominence by Sir George Watt, who points to it as the only sure hope for the elimination of blights from our tea gardens. Without going so far as Sir George Watt on this point, it is yet reasonable to suppose that the seed from a healthy tree is much more likely to produce a healthy plant than that from a sickly one; hence the seed should be gathered, not from an entire plot of tea grown by itself, but from selected healthy and suitable plants over a large area. Some planters have put this idea into practice for years with most satisfactory

Seed from ordinary cultivation.

results. No separate plot is allowed to grow specially for seed, all tea is pruned and plucked in the ordinary way, but seed is gathered from the best plots, and only from selected healthy bushes in those plots. By this system only a few seeds can be obtained from each bush, but, as with fruit trees, when the quantity of fruit is restricted by pruning, the quality is proportionately improved, so, in this case, the small quantity of seed obtained is robust, full, and healthy, and its germination can be depended upon. The seed from plants which have proved to be not only high class, but also blight-resisting, is sure to give the best results; and this is the only seed fit for propagation..

Tea flower and seed.

The tea flower appears any time between July and October, and about fourteen months elapse before the seed is ripe. It is carried in a thick capsule, sometimes bearing a single seed, sometimes three or four seeds together, (See illustration, Fig. 3).

When the seed is ripe, the capsule assumes a dark green or a purple tinge, after which it begins to dry and shrink, which causes it to burst, and the seeds fall to the ground. The seed is about the size of a boy's marble, the kernel being protected by a hard shell of dark brown colour.

Plucking seed.

The greatest caution is necessary to ensure that the seed is fully ripe before being plucked; this is the more difficult, as the seed on a bush does not all ripen at the same time, and if the whole crop is wanted, a gang of pluckers must go round twice or three times, taking the seed as it becomes ripe. It may be plucked from the tree or gathered from the ground immediately after it has fallen.

Fallen seed.

Seed which has lain on the ground for some time may not be very reliable—not that the soil injures it—but for the simple reason that the damp

Fig. 3.—Leaves, flowers, and fruit of Tea.

arising from the ground very soon induces *germination*, by which process the active life of the plant in embryo has begun, and the possibility of the germ being or remaining dormant has ceased. The plant must either be placed in circumstances where life can go on expanding or death is the result.

Treatment in factory.

Immediately the seed has been brought into the factory in its rough state, it should be spread on the floor of a cool airy house or verandah, not more than three inches deep, and be kept overnight. In the morning it is to be sorted by hand, all refuse cleaned away, and all unopened capsules spread on a mat out of doors, so that the sun or wind may dry and crack the capsule. When this is done in a hot climate, care must be taken not to expose the seed too long, because the extreme heat of the sun is very liable to crack the *inner* shell of the seed also, in which case it has become destroyed.

Empty shells.

There is always a proportion of the seeds, more or less large, which are mere empty shells without kernel. These may be detected by placing some seed in a vessel of water, when the empties float very lightly. Some managers dislike the water test, as tending to untimely germination, and prefer that the empties should be detected by the eye, tested in the hand, and picked out. Intelligent coolies learn to do this in quite a wonderful way.

Seed may be rapidly tested by being placed in a wire basket or sieve, and then dipped bodily into a trough of water. After skimming off the empties, which float lightly, the whole can be lifted out and dried again in the sun, before the water can have any damaging effect upon the keeping qualities of the seed.

It is important to note that tea seed may remain on the surface of the ground for several months without spoiling, provided that heavy rain does not fall and wet

the ground sufficiently to induce germination. Seed has been gathered in January in perfect condition and has given satisfactory results, although similar seed, gathered in October and stored in a factory, lost its vitality in three or four weeks.

Packing seed.

If the seed is to be carried to a distance, it should be packed as soon as possible after sorting. Some planters pack it in watered sand or sand and charcoal, so that it germinates during the journey. This is a dangerous practice, however, because the contents of the chest may get dried through some unforeseen delay or exposure to heat (sun or otherwise) with the result that the germinated seeds, or rather young plants, are sure to die.

It is better to keep the seeds in a dormant state, and experience has shown that the best mode of packing is with dry charcoal dust, with perhaps a little earth mixed. This has a wonderfully antiseptic effect upon the seed, and will preserve it in a dormant state for a long time. The dry charcoal absorbs any moisture given off by the seed, so that it is preserved from internal heating and fermentation. The seed must be packed in layers, with sheets of strong paper between, to keep the charcoal-dust from getting to the bottom of the chest.

If the seed has to be taken a very long distance, or, for any reason, cannot be sown for some months, it must be packed in tin-lined cases and hermetically sealed. In this way it has been known to keep its vitality for several months.

For this purpose, it is necessary to see that the seed is cleaned and packed immediately it becomes ripe. Only seeds which sink heavily in the water may be used, all refuse sorted out.

Tea seed very soon loses its vitality, and should on no account be kept in stock for any length of time. If the nurseries are not ready for its reception, it may be

kept in dry charcoal-dust or in sand, or it may be put into germinating beds, watered and tended in the usual way.

It may be noted that seeds of high class plants are more delicate and lose vitality more readily than hybrids.

Fermentation of seed.

In keeping tea seed, it is of the utmost importance to note that immediately after being gathered, it has a great tendency to *ferment* if kept in a close condition. Let a large basket or a box be filled with fresh seed overnight, and in the morning the contents will have become so hot that the bare hand cannot be thrust into it. When this has taken place, the seed has fermented ; it will *look* all right for a time, but the greater portion of it is dead, and the process of rotting is only a question of time.

This is undoubtedly the most fruitful source of disappointment regarding tea seed, and the matter is deserving of the most serious attention.

Until ready for packing or planting, the seed must be kept spread out, as before, to a depth of not more than three inches.

Testing seed.

Testing seed to ascertain the percentage of good is not so simple as is generally supposed. To throw a handful into a pail of water is by no means a correct test, because if the seed has become a little dry, 80 per cent. or more will float, although perfectly good, while any seeds whose shells have been broken by rough usage will *sink*, as well as some other rotten and bad ones.

The ordinary way with careful planters is to count out a certain number of seeds, say, 100, and then crack them all, examining the kernels one by one ; even this is not an accurate test, however, because the *empties* weigh *very little*, and as the seed is sold by weight, the only accurate method is to weigh the proportion of bad against that of good.

With regard to the quality or condition of tea seed, a Form of Contract has been agreed to by the Indian Tea Association, whereby it is assumed that seed should be at least 90 per cent. good when packed at the garden in Assam; 75 per cent. at Goalundo, and 70 per cent. by the time it reaches Calcutta.

Rules for soundness.

This shows how rapidly tea seed loses its vitality, and how important it is to get it into the ground as soon as possible. Germinating beds or nurseries should be ready for the seed *before* it comes to hand.

Rapid loss of vitality.

Germinating beds may be made by clearing and digging a piece of ground thoroughly to a depth of a foot or more; level off; cover all over with six inches of fresh manure; cover that again with four inches of light well-pulverized soil, on the top of which the seed may be spread, not touching; cover over with two inches of fine sifted soil or sand. Water abundantly every second or third day, or, if in cold, cloudy weather, once a week or ten days. If the climate is cold, glass frames may be necessary in order to generate sufficient heat.

Germinating beds.

On many hill-gardens, where there are good spring rains, a favourite method is to plant out with germinated seed "*at stake.*" The germinated seeds are taken very carefully out of the bed and placed in a small vessel containing some liquid manure, and each cooly takes his own lot to the land which has previously been prepared, lined and staked, with holes made at the stakes where the plants are to grow. In one of these holes the cooly carefully places one or more seeds in such a way that, when he fills up the hole with loose soil, the seed will be about two inches from the surface. He then puts a handful of grass over all to keep the sun from drying it up.

Seed at stake.

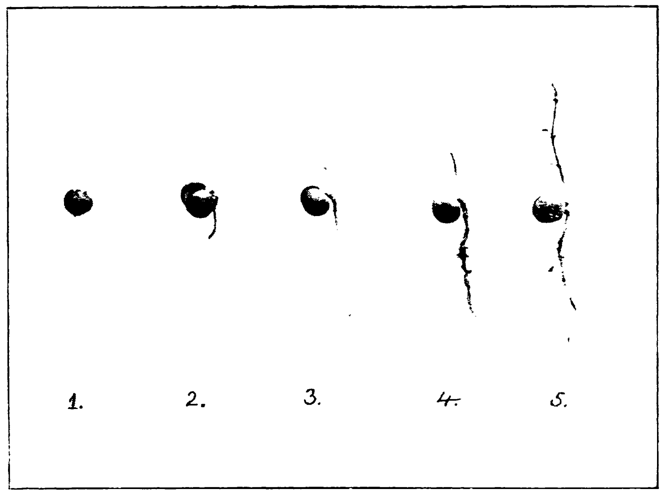


Fig. 4—Development of Germinated Seed.

First growth. It should be noted that the finger-like shoot which first comes from a seed on germination is not the stem, but the *root*, and in planting germinated seed, this must be put *downmost*. (See illustration Fig. 4.)

Nurseries. In selecting land for nurseries, some planters say that they prefer poor soil so as to raise hardy seedlings, which will feel the benefit when transplanted into good soil.

This is absurd, because healthy plants cannot be raised on poor soil. It is like starving a child in order to render it hardy. The young plant must have everything in its favour, and be as robust as possible, so as to stand the shock of transplanting successfully.

Old nurseries. Land which has previously been the site of a nursery should not on any account be used for this purpose again, unless it has lain fallow for several years, and even then it must have a liberal dressing of rich forest mould or manure Lowlying or water-logged land is unsuitable for a nursery.

Ball planting. If it is intended to use the transplanting machine when planting out, the land selected for nurseries should be of light friable soil perfectly free of stones. If the intention is to transplant in the cold weather with balls of earth by hand, a fairly stiff clay will be found the most suitable.

The land should be thoroughly cleared ; all roots grubbed out and carried off. It must then be dug all over to a depth of two feet ; all sticks, stones, and rubbish being brought to the surface and carried off. It should be gone over a second time, with *forks* for preference, all lumps broken up and the soil thoroughly pulverized and all twigs, etc., sifted out.

Nursery beds.

Beds should be laid out five feet wide with passages one or two feet wide between. The earth from the passages to be thrown up on the beds until they are nine inches or a foot high, or even higher if the land is at all low-lying; the passages then serve the purpose of drains and also of a receptacle for weeds when hand-weeding becomes necessary. If the soil is light and the situation dry, the beds should not be raised higher than three or four inches, so as not to be so liable to drought.

Distance apart.

The seed may be sown about four inches by four inches, which is a good workable distance even when the transplanting machine is to be used. For cold-weather transplanting, the seed is sown six inches by six inches and sometimes even as wide as nine inches by nine inches, but when sown so wide, the seed must first be germinated in germinating beds, to ensure having as few vacancies as possible.

A disadvantage in wide sowing is that it does not allow for weeding out inferior plants previous to the actual transplanting. In all nurseries, however good class the seed may have been, a certain proportion of plants come up showing poor *jât* or sickly habit. Such plants are to be rigorously weeded out, if the ultimate result in the plantation is to bring full credit to the management. If the seed is sown as closely as four inches by four inches a good many plants may be thus weeded out while the plants are young, and a selection of the finest and healthiest will remain in the nursery at a good workable distance for transplanting.

An excellent implement for sowing with consists of a board, five feet by one foot six inches, drilled with holes in three lines, four or six inches apart. (See illustration.) This is laid across the bed; a cooly stands at each end, with round sticks for boring the ground,

which is done through the holes in the board, and they can together bore and sow with wonderful rapidity.

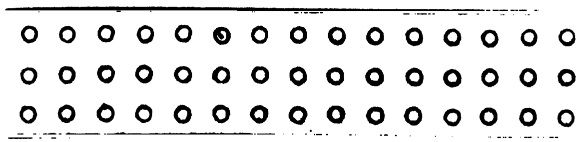


Fig. 5. Seed Sower.

The seeds should be sown about one to two inches below the surface of the ground.

Seed which is in bad or doubtful condition, or very expensive seed, should be put into beds for germinating before sowing in the nursery.

Watering.

In watering nurseries, care should be taken to see that when done, it should be done thoroughly. More harm than good is done in dry weather by merely sprinkling a little water on the surface every day ; the sun drying it off in a few minutes, the only result being that the surface becomes *caked* and cracked, so that the seeds are in a drier state than if no water were applied at all.

When water is applied, the soil should be *soaked ;* then no more watering until it has become moderately dry again, which may be only one day in a hot, dry situation, or it may be three or four days or longer. In moist situations it may not be necessary to water at all.

Heat required.

One thing to be remembered is that the seeds require the warmth of the sun, as well as the influence of moisture in order to germinate satisfactorily.

Covering with grass.

A very common custom is to cover the beds with grass immediately after sowing in order to keep in the moisture. This is very good if the situation is very hot and

dry; if water cannot be had for watering the beds, it is absolutely necessary to cover them, but in ordinary circumstances it is a hindrance rather than a help, as it hinders the action of the sun upon the ground.

Shades.

As soon as the young plants appear above ground, care must be taken to water only morning or evening, unless the beds are shaded by raised tatties of grass or mats. Tatties are necessary in a hot climate, especially if the seed used is of a high class.

Nurseries should be frequently weeded by hand; if any weeds are allowed to grow with the tea, the latter will soon get sickly. The operation of pulling up the weeds is also beneficial by breaking the surface of the soil, which is very apt to become caked by frequent watering and drying.

The quantity of seed required for planting a new clearance depends upon the system to be adopted in planting.

Seeds per maund.

The number of seeds in a maund (82 lbs.) varies greatly, and may be from 12,000 to 20,000 or even more, if of poor *jât*. In ordinary circumstances, it is safe to expect about 8,000 plants from a maund of really good high-class seed.

The following table shows the area which can be planted with one maund of seed, if the lining is rectangular

With triangular planting about 15 per cent. must be deducted from the area in each case.

Plants per acre and Area per maund of seed.

Feet apart.	Plants per acre.	Acres per md. of seed.
4 × 4	2,722	3
4½ × 4	2,420	3½
5 × 4	2,178	4
5 × 5	1,742	4½
6 × 6	1,210	7

These figures are on the assumption that the nurseries are successful, and the planting out equally so; but it often happens that the seed is indifferent in quality or that germination may be slow and growth backward, so that plants in sufficient numbers may not be ready in time.

Extra seed for contingencies.

It may be also that for some reason the first planting out will be a partial failure, and large areas will have to be replanted. All these things considered, it is well to have a good margin for contingencies, and quite 50 per cent. extra seed should be provided.

Propagation by cuttings.

Propagation by cuttings has been tried, but in all cases proved unsatisfactory. It is against the natural construction of the tea plant, which depends much on its tap root piercing deep down into the ground, and so gathering moisture from the subsoil in seasons of drought.

Selection.

In all nurseries there come up a certain proportion of bad *jât* or of sickly plants. These must not be used for planting out, and as soon as they are fairly distinguishable, they should be uprooted and thrown away as weeds.

Seed gardens.

In laying out a garden which is to be used exclusively for the production of tea seed, the first consideration is that the site should be well-drained, and the soil a light loam with good depth; the conditions generally such as are considered necessary for a fruit orchard. The situation must, of course, be as far away as possible from any place where tea of inferior class is growing, and from the boundary of any adjoining property where tea of inferior class might in future be planted. This is necessary to ensure that the seed, which will ultimately be produced, shall not be liable to hybridization from flowers of inferior tea.

CHAPTER VI.

Preparation of land and planting.

Opinion is somewhat divided as to the extent of preparation necessary in order to ensure success. The wisdom of very elaborate preparation has sometimes been questioned, but as a result of experience the tendency now is distinctly in the direction of more thorough work, as being the best economy in the end.

Rough methods.

In the early days of planting tea in the Dooars, it was very customary merely to cut grass land, burn it, grub out the roots of elephant grass, stake and dig holes, and then put seed at stake—sometimes germinated and sometimes not. The large roots of elephant grass were set on edge to form a partial shade for the young plants when they appeared.

It was wonderful how successful the planting of some gardens was, although the method was so rough. This was no doubt due, in a large measure, to the advent of good spring rains, although also of course to careful and efficient supervision. On the other hand, many clearances treated in this rough way proved an utter failure. The general result of experience is that much more caution is now exercised, and more thorough preparation the rule.

Forest clearing.

For clearing forest land, the system generally adopted is to commence operations immediately at the close of the rains, cut brushwood and undergrowth, then leave it to dry, after which a fire is sent through it. The trees are then felled, leaving as short a stump as possible : the branches are lopped and time again given for drying, when fire is sent

through. All heavy timber remaining after the second fire is then prepared for enginewood or charcoal and is removed to the factory. The land then receives a good hoeing all over, all small roots being extracted, and only the roots of large trees left to rot away in process of time.

Stump rot.

In some parts of Assam a very peculiar thing is common in connection with clearances of forest land. After the stumps of trees have begun to rot and the young tea plants are three or four years old, the tea on large patches of ground here and there gradually dies out, leaving a vacant space about 20 feet in diameter. The damage is done by a root fungus, which germinates readily upon the rotting stumps of trees ; some trees being more liable to it than others, and in some situations it comes more readily than in others ; but after becoming established upon a rotting stump, it gradually causes the death of all tea-bushes within a certain radius. A singular fact is that it affects only such tea as may be growing within the area occupied by the roots of the stump. It is impossible to say whether any particular tree may or may not be immune from stump rot with its devastating effects.

The only precaution against it is to grub up all the tree roots at the time of preparation of the land.

Thorough clearing.

This leads us to the consideration of the system of more thorough clearing and preparation previous to planting new land. It is much more expensive than the usual plan, but yields very satisfactory results.

Instead of trees being cut down they are *uprooted*. A large ring is dug round and the lateral roots cut, when the weight of the trunk and branches helps to complete the work and, in falling, tears up the remainder of the roots.

Bamboo clearing.

Bamboo clumps are treated in the same way, although in this case the

work is exceedingly laborious and expensive, sometimes as many as twenty-five or thirty coolies being required to uproot one clump. After the clump has been turned on to its side, the bamboos are all cut off short at the root, and if the clump is a large one, it must be divided into several pieces before it can be removed. On steep hill-sides, the removal of these roots and stumps is simple, as they are just rolled down-hill into the ravines, but on the plains there is great difficulty, all roots having to be dragged away by elephants.

On some gardens in Assam, as well as Darjeeling; this system of clearing has been carried out with great success and very satisfactory results.

Trees in tea.

In most instances it is advisable to have a few trees standing in the clearance in order to give shade here and there to pluckers for spreading their excess leaf during very hot weather. Some kinds of trees are very injurious to tea and should not be allowed to remain on any account; amongst these are the *sal*, the various kinds of *chestnut*, the *chillow**nee*, etc. There are certain kinds of trees, however, which do little or no harm to tea growing under them, to this class belong all the leguminous tribe, as well as some others.

Trench-digging.

After the roots are all grubbed and cleared away, the land has to receive a trench-digging all over. The coolies start at the boundary line and dig at least 18 inches deep, pulling the soil back and so forming a trench; as they work forward, they fill this trench in and so form a new one, keeping a trench always ahead of them. In this way it can be seen that the ground is dug thoroughly to the required depth and the soil well *mixed*. All lumps are broken up, all stones and roots sorted out and thrown up on the surface to be collected and carried off by gangs of men and children coming behind.

On steep hill-sides it is advisable to use the stones thus brought to the surface for building along the sides of roads and for building low walls or terraces, at intervals across the hill to prevent loss of soil by wash during the rains. By this means the stones which are usually considered a nuisance become of great value to the property, as a means of retaining the best constituents of the soil by preventing wash during the many years of cultivation to come.

Walls to prevent wash.

The alignment for these stone terraces must be determined by means of a suitable instrument, such as the "self-registering clinometer."

Clinometer.

The formation of the land on steep slopes into soil terraces is, of course, very desirable and necessary, but not at the time of opening out, as the usual custom is. When terraces are formed before planting, the work is done by digging out the back part and using this soil to form the outer edge of the terrace, thus covering over part of the ground containing small roots and jungle of all sorts, which will grow in future and for a time claim all the nourishment available in the soil. The tea plants are placed in the back part of the terrace from which the surface soil has all been taken away, and it is consequently planted in *sub-soil.* The natural result of all this is that the tea makes very little growth while the jungle thrives amazingly. Another objection to terraces formed in this way is that they are usually too prominent and are apt to get broken down more or less completely by their own weight and the trampling of coolies. A very serious consideration also is that when terraces are formed at right angles, the whole ground suffers very severely in times of drought, as there is such a large surface exposed to the drying influence of sun and wind.

Terraces.

The best plan is to form terraces gradually after the land has been planted. At the time of lining out and staking, however, this must be kept in view, and the planting so arranged that it will be possible in time to come to make up suitable terraces which will follow the contour of the hill.

Immediately after the tea has been planted, the process of forming the terraces begins. At every time of hand-weeding the weeds are laid in lines across the hill immediately above the lines of tea plants; these weeds so placed prevent wash, and the soil which they catch forms the nucleus of the terraces which are gradually built up at every time of weeding, and subsequently at every time of digging.

In Java, it is now customary to fortify the front of each terrace by planting leguminous shrubs, such as *Leucaena glauca* which has proved of great value, in arresting and retaining the very light volcanic soil. In Darjeeling, the Boga medeloa has been planted in some estates for a similar purpose. These plants are frequently lopped; the branches being laid along the face of the terraces, forming valuable manure, besides binding the soil.

Distance apart.

The usual distance for planting tea is four by four feet for ordinary hybrid varieties; but the distance advisable varies greatly according to circumstances. On comparatively poor soil, hedge planting 5 by 3 is sometimes best; while for very good soil and a forcing climate, the distance should never be less than 5 by 5. In some circumstances even 6 by 6 gives the best result with pure Assam indigenous plants. The tendency of late years has been to put the plants too closely, on the assumption that the bushes may be kept small in size under an intensive system of cropping. This, however, is leaving out of account the question of ground space for the roots. The natural size of the

Assam tea tree is 30 feet high, with a width of foliage about 20 feet, and a corresponding spread of roots, occupying a circle of ground not less than 15 feet across. However much the bush above ground may be cut and dwarfed, the roots underground still demand their natural development; and there is a limit under which the bushes cannot be crowded if the fullest advantage possible is to be got from the plantation. It is recognized in all kinds of agriculture that overcrowding is an unpardonable mistake.

Close planting.

Close planting pays well only during the early years of growth; but whenever the roots of the bushes begin to struggle against one another for the available ground space, the health of all must inevitably suffer. Hence it is urged that under favourable circumstances of soil, climate, and class of plants, a distance of 6 by 6 feet apart is not too much.

The writer knows of a plot of tea 6 by 6 feet which was planted 21 years ago on a hill-garden at an elevation of 3,000 feet, and which for several years past has regularly yielded 11 maunds of tea per acre. This without manure, or any special treatment, except that Siris trees had been interplanted amongst the tea.

Lining and staking.

On level country the lining out is a simple matter, if done carefully. Any little inaccuracy, however, at the start multiplies itself as the work goes on, hence the utmost care is necessary, especially in the preliminary operations. At least two lining chains are necessary, with marks fixed to them at regular intervals, at the distance which it is intended to plant. If chains are not available, strips of hoop iron may be made to do very well; they should have an iron shackle rivetted to each end for pulling with, and holes should be punched for the marks at the proper intervals, these being very carefully measured. It should be remembered, however, that hoop iron soon

stretches with usage, and it must be measured and checked from time to time.

A square (or for triangular planting, a rhombus) is first formed, each side being the exact length of the chain, and a stake put in the ground at each mark. The most careful and experienced men then simply produce the sides of the square indefinitely, forming new squares all over the land until the whole has been taken in. The filling of the squares with stakes is a work which can be done without difficulty.

Roads. Size of blocks.

In allowing for roads the modern custom is to lay off the garden in blocks of ten acres each; the blocks being divided by roads and paths.

Triangular planting.

Lining for triangular planting is similar to the rectangular method, only that the beginning is made by forming an equilateral triangle, on the base of which another of the same is constructed, so forming a rhombus. The sides of the rhombus are produced similarly to the square, but in all cases the main lines should be carried out perfectly straight and equi-distant. It will facilitate this if at intervals a mark, such as a piece of white paper, is fixed to the stakes; the naked eye can then detect whether the papers are in a straight line.

There has been much discussion as to whether rectangular or triangular planting is better. Opinion is now generally in favour of the latter; it is certainly better up to a certain age, because the roots of the tea will occupy the whole of the ground sooner than by the former method.

Fruit gardens.

The difference is not great however. All modern fruit gardens are planted on the triangular method, but in the case of fruit the question is of much greater importance, the trees being planted 20 or 30 feet apart, and the area of

unoccupied ground with rectangular planting is relatively much greater, and takes much longer to fill up.

Lining hill gardens.

To line hill-gardens properly is very difficult, and the work requires constant supervision. Here the chain is of no more use than a rope, as the undulations and changes of contour of the ground make it impossible to work out straight lines both ways, and it is also impossible with a chain to get level or base measurement on ground with a varying slope.

The first consideration is to get lines running straight up and down hill at an equal number of feet apart (base measurement), and carried out unbroken over as large an area as possible. Some of the old hill-gardens have been lined in a most promiscuous way, one consequence being the extreme difficulty in checking coolies' tasks and more or less of a continual muddle amongst the pluckers.

The lines must be *regular* at least one way.

Each hill-side must be lined separately. A rope is stretched right from top to bottom, as nearly as possible in the middle of the plot. Ten other ropes are then stretched parallel with the first at the distance determined upon; this distance is measured by a rod of the exact length. The *measuring* must be at *right angles* and must be *base* or level measurement. A cooly now begins staking from the top of the first line; after planting one stake, he places one end of his measuring rod at the base of it and holding the rod as nearly level as possible and in line with the rope, drops a small stone from the other end of it; the place where the stone strikes the ground is the spot for inserting the next stake. This process is repeated all down the line, and in this manner the stakes will be exactly the same distances apart (base measurement) whether the slope of the hill be little or much. The other lines may be staked in the same way.

The above style of staking admits of terracing only on the *honeycomb* principle, a small terrace for each plant; but if regular terraces are required, the staking will take a little more time and care. After the first line has been staked, the tenth line is done; then the intervening lines are staked, not by measuring, but judging by the eye, so that the lines of terraces formed by the stakes will be regular contour lines as nearly level as may be on the hillside. With varying steepness of land it may be necessary to run out a terrace, or to insert an additional one, as circumstances require; so that the terrace beginning at, say, No. 4 on the first line, may merge into No. 5 of the tenth line; No. 4 on the tenth line being treated as an extra terrace. It is impossible to keep the terraces exactly the same distance apart, but the measuring rod must be used occasionally, to keep as near the distance as possible. Where the land becomes very steep, fewer terraces will be possible with the same width; hence here and there a terrace must be run out, and when the land becomes more level again, new ones must be inserted. After a day or two's training any intelligent workman will pick up the idea, and will carry on without much trouble, but the manager or assistant must keep a constant eye on such work.

Staking for terraces.

When all the stakes have been placed in position, a separate gang of men or boys go round with mallets driving them deeply and firmly into the ground.

Holing.

The holes for plants should be dug alongside the roots of the stakes, and must be all in the same direction.

Transplanting.

A very common error in regard to transplanting in the rainy season is to begin too soon, the planter being eager to get as much done as possible before the heavy growth of jungle and leaf comes on. After a shower of rain has fallen, the

work of transplanting is started with a large staff, and goes merrily on for two days, after which, alas ! a few days' hot sun completely ruins all that has been done. It is impossible to lay down any rule as to the date for beginning to transplant, but a good rule is to wait until the ground has become *thoroughly wet* to a depth of at least 18 inches. On hill gardens at high altitudes, this will be earlier than on gardens on the plains and may even be in April or May, but at low elevations it will not be till the regular monsoon rains are on. It is not by any means necessary that rain should be falling at the time that the work is being done ; in fact, it is better not to be raining. Cloudy weather, or even sunny weather, with good rain at night, is perfect for transplanting.

Time for planting.

Rainy weather not necessary.

Very successful work can be done with the machine. The *Jebins Transplanter* was first in the field. There are several improved patterns now in use. It is much more expensive to work with the machine than in the usual way, because it takes up a large ball of earth with the plant, and the carrying becomes a serious item. This, however, can be minimized if the nurseries are formed at intervals as near as possible to the ground which is to be planted. When the plant has been taken up by machine with its ball of earth, it is slipped into a tin cylinder, the moveable bottom of which may be simply a large leaf from the jungle (which is better than the usual tin bottom). The plants are carried in rows in an oblong box or frame, and a man can carry about 16 of them at a time.

Transplanting Machine.

When the planting cooly receives the cylinder with its plant, he slips away the leaf from the bottom ; looks to see that the ball has not got broken ; if the end of the tap root is protruding and bent, he either straightens it

Method of planting.

out or nips the thin piece off, and then places the cylinder, with the plant, into the hole; loose earth is then filled in all round when the cylinder can be lifted out, leaving the plant in position. The earth is then rammed in moderately all round, and a little loose earth put on the top. The *ball* itself should on no account be rammed or broken.

Only young seedlings can be transplanted in this way; those of eighteen months or more must be done entirely by hand.

If the nursery has any gravel or small stones mixed with the soil, it is impossible to use the machine.

Hand planting.

In transplanting by hand, the thing of first importance is to see that the plants are taken out of the nursery with sufficient care. A deep trench must first be dug in front of the line to be operated upon; then a garden fork inserted behind each plant, bringing it gently into the trench with a ball of earth attached; the greatest care being taken to protect the fine lateral rootlets and to keep them in the soil upon which they have been feeding. This soil is then made up into a ball round the plant and wrapped with green leaves; it is placed in a basket or box, to be carried in a horizontal position, to its destination. If the soil is rather stiff, it should not be pressed too tightly round the plant; otherwise stiff clay will strangle it. Coolies who have been used to transplanting rice are very fond of pulling up tea seedlings as they pull up rice plants, and it is small wonder that less than 50 per cent. of such seedlings manage to survive. The planter should as often as possible examine the plants as they are being carried, and he will at once see if they have been roughly treated. On opening out the ball of earth, it will be found that the laterals are injured or completely torn off, and the bark of the tap root more or less lacerated.

Ball of earth.

Want of laterals.

It should be noted that any plant which has few or no laterals had better not be planted, even if the tap root is thick and healthy-looking. The plant draws little or no nourishment by its tap root ; all is taken up by means of the fine fibrous laterals, and if there is a deficiency of these, it will have a very small chance of standing the shock of transplanting.

Old plants.

Plants which are eight or ten years old may be transplanted successfully. They must be pruned back to 12 or 18 inches, and the roots also pruned moderately, but not more severely than is absolutely necessary. If the plants are two or more years old, it is impossible to carry them with balls of earth, because the roots are so large. They must, however, have as much soil left as will stick to the rootlets : and a piece must be pruned off the thin portion of the tap root. In carrying these plants from place to place, care must be taken to protect them from *rain* as well as sun ; otherwise heavy rain will *wash* the soil from the fine rootlets, and so make it much more difficult for them to survive. It is no unusual thing to see, in the transplanting season, coolies carrying bundles of seedlings for long distances, suspended at the ends of a pole, with roots all exposed and without cover or protection of any kind whatever from sun or rain. Many of such plants are, of course, already *dead* before they are put into the ground, and no amount of care in planting will resuscitate them.

Protection from rain.

The actual planting is the work which requires most care, but there are several simple rules of procedure, which, if attended to, will ensure success.

Rules for planting.

1. The end of the tap root may be cut clean off, but it must not be bent or doubled up.

2. The plant must be placed so that the *collar* is level with the surface of the ground. If placed too high, some of the roots will be exposed; if too deep, the bark of the stem (which is different from root bark) will be injured by being buried.

The plant should be at the same depth in the ground as it was in the nursery.

3. The laterals should be spread out, not driven into a clump round the tap root.

4. The hole should be only one-third filled with earth, which is then pressed round the plant by hand; one-third more filled and trodden or rammed moderately and the remaining third filled in but left *quite loose.*

Depressions on surface.

Some planters have a saucer-shaped depression round the plant in order to retain water. This is a mistake, because the tea plant cannot thrive in sodden ground or stagnant water. The soil must be filled in quite to the level of the ground, but if left loose and soft on the top, it will remain sufficiently moist.

Failures.

It is usually some little time before failures become apparent. Even when the root has not "taken," yet the plant has a certain quantity of nourishment stored up in the stem, and on this it exists for a few days before pegging out. If in wet weather a plant is merely thrown upon the ground it will remain quite fresh-looking for several days. It will thus be seen that the planter should not be too sure about the success of his work until it has stood the test of time.

If after a month or six weeks the plant still shows signs of life, it will probably do all right, but the true testing times are October and March, when the intense heat is pretty sure to snuff out those which have not a good grip of the ground.

Shedding leaves.

Sometimes it is found that within a short time after transplanting, a plant has shed all its leaves, and only the bare stalk remains. One naturally supposes that such a plant has died ; but this is not so, it is a sign of life ; the plant has sustained a severe shock, and recognizing the fact that it is unable for the time to support evaporation from its leaves, it casts them off. The root is actively trying to lay hold of the new soil and is putting out feelers in every direction ; the plant is struggling for existence, and will probably succeed. After a time young leaf buds will appear on the stalk at the axils, where the leaves were cast off.

Plant instinct.

This is one of the remarkable illustrations of plant life, and of plant *instinct* for self-preservation. It is the more remarkable, because the tea plant is an evergreen, and this is probably the only occasion in its life when it sheds its leaves all at once.

It may be observed that if, after transplanting, the leaves wither and become red on the stem, *without falling*, the case is a hopeless one ; the plant is dead.

Cold weather planting.

Transplanting during the cold weather with balls of earth, when properly done, is the most certain way to success, but it is also the most expensive way. Where the labour force is strong and a moderate amount of work has to be done, success may be assured in this way.

The plants must be very carefully dug out with a small spade, one by one, each being contained in a hard ball of earth, and then carried to the spot for planting. A good deal of labour must be spent upon the digging out from the nursery, as this cannot be done in an off-hand way, for the balls must be laboriously picked out and cautiously separated from the mass ; an old pruning knife is very useful for this. If the seedlings are too

close in the nursery, two or even three plants may be taken in each ball.

The essential features of this work are :—

Rules for ball planting.

1. The balls must be absolutely unbroken, either in taking up or in planting.

2. They must be at least six inches in diameter, and 12 inches in length, but still larger balls are desirable.

Age of maturity.

With gardens on the plains, in a forcing climate, the plants are expected to yield after the third year a half crop, and to attain to full bearing in the sixth year after planting.

Hill gardens are much slower in coming to maturity, which some do not attain until the tenth or even the twelfth year.

A table is here given showing the actual results obtained from a hill garden, at an elevation of from 1,000 to 3,000 feet, which may be taken as a garden practically between the hills and the plains. It should be mentioned, however, that it was put out by a very successful planter who has now retired, and was done with more than ordinary care and skill.

Average yield.

The average yield from gardens in Assam has, in recent years, increased to about 723 lbs., per acre; Cachar and Sylhet 590 lbs., Dooars 684 lbs., and Darjeeling 364 lbs. The tea from all India in the yerr 1918 was 609 lbs. per acre.

Cost per acre.

The total cost of bringing a tea garden to maturity, as mentioned elsewhere, varies very much, and may be anything from Rs. 300 to Rs. 800 per acre, or even more, including buildings, machinery, and all accessories. The chief factors are the difficulty or otherwise of clearing, the cost of labour and the *success* or otherwise of the operations in the first instance. The most important question of

Table showing Results from a Young Garden.

Year of Operations.	1877 Planting = 3 acres.			1878 Planting = 55 acres.			1879 Planting = 89½ acres.			1880 Planting = 45½ acres.			1881 Planting = 31 acres.			Total.
	Proportion of yield for age.		Crop.	Proportion of yield for age.		Crop.	Proportion of yield for age.		Crop.	Proportion of yield for age.		Crop.	Proportion of yield for age.		Crop.	Crop.
	Acres.	Mds.	Mds. Tea.	Acres.	Mds.	Mds. Tea.	Acres.	Mds	Mds. Tea.	Acres.	Mds.	Mds. Tea.	Acres.	Mds.	Mds. Tea.	Mds.
1877 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1878 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1879 ..	3	@ 1½	4½	..	..	..	..	..	..	..	..	..	..	..	..	4½
1880 ..	3	@ 2⅓	7	55	@ 1¼	69	..	..	..	..	..	..	..	..	..	76
1881 ..	3	@ 3	9	55	@ 2	110	89½	@ 1¼	104	..	..	..	..	..	..	223
1882 ..	3	@ 4½	14	55	@ 4	220	89½	@ 3	268	45½	@ 1⅜	60	..	..	..	562
1883 ..	3	@ 5	15	55	@ 4½	242	89½	@ 3½	312	45½	@ 2½	114	31	@ 1¼	40	723

NOTE.—This garden was subsequently increased to 279 acres and is now yielding on an average 6 maunds (480 lbs.) per acre of high class tea, year after year, which may be reckoned as the average crop after ten years of age, and shows what can be done even on a hill garden.

all is, of course, with regard to the skill and ability of the management.

The actual cost per acre cannot be always taken as indicating the value of the property, because in some instances an enormous amount of money has been spent upon repairing repeated failures, and in other cases the total area includes dozens or even hundreds of acres which should never have been planted, and which, so far from being any benefit, form a continual drag upon the resources of the property.

Possible age of tea.

The question as to how long a tea bush will live has often been asked, but at present there seems to be no reliable data to go upon. Some tea, which was planted in Assam upwards of sixty or seventy years ago, still seems as fresh and vigorous as ever, and yields very well. There are lots of gardens with tea forty and fifty years old, yielding as well as any and, where growing on good soil, the bushes show no sign of old age or decay. Some planters, whose experience gives their opinion weight, have stated their conviction that the tea plant can, under favourable conditions, exist and thrive for a hundred years.

Filling vacancies.

Filling vacancies in old tea is one of the most difficult things possible; chiefly because the ground has already all become occupied by the rootlets of the old bushes, and the young seedling, therefore, struggling for existence, has small chance against its full-grown neighbours.

In order to ensure success, it is essential that a large hole be made, and *fresh soil* or manure brought for the young plant before planting. A seedling of eighteen months is too young for this; it should be not less than three years old.

Very old plants.

In some instances very successful work of this sort has been done with plants as old as seven or eight years. In this case, they

must be pruned in the nursery before being taken up, and may be left two feet high. The tap root must also be cut, leaving it about two feet long. It should be noted that coolies are fond of cutting *too much* off the tap root, because the shorter they leave the root, the easier it is to plant. Laterals will also require to be pruned to a moderate extent. With a good deep hole and new soil such plants grow with wonderful vigour.

Wherever vacancies are found in a garden, they should receive the best attention of the management and should be made good as soon as possible. There are many estates where the vacancies are from ten to fifteen per cent., or even more. Taking it as ten per cent. on a garden of 1,000 acres, this means that there are 100 acres of plant wanting, and that a 100 acres has to be cultivated all the year round with the rest, but is producing little or nothing, and the expenditure on it is a dead loss.

Surveys.

It is a remarkable fact that the great majority of tea estates have never been surveyed, or have been only partially surveyed. This naturally results in a great deal of confusion in many instances, particularly in connection with accounts, in reckoning the crop per acre and the various details of working, as well as in comparison of results of one estate with another in the same Agency.

Improved Surveying Staff.

The Director of Surveys for Bengal recently expressed the opinion that with a suitably simple instrument, it should be possible for every planter to survey his own estate quite accurately ; such an instrument has now been invented by the author, named the "Improved Surveying Staff," and will shortly be available, together with a monograph of instructions. It is constructed on a new principle, combining simplicity with accuracy.

CHAPTER VII.

ROADS.

FOR gardens in level country, the construction of roads is comparatively easy. Garden paths are usually about 12 feet wide, including a drain at one or both sides, the soil excavated from the drain being used for raising the road.

Main roads require to be 20 feet wide or more to allow of cart traffic and to allow two carts or other vehicles to pass. The tendency generally now is to have wide roads traversing most parts of the estate, so that managers may get about freely by *driving*, or motoring, which is so much less exhausting than saddle work.

Culverts.

In connection with the drainage system of the garden, culverts may be necessary at intervals and must be provided at all crossings. It is necessary to have these either of stone or brick, or merely bridged with very substantial hard timber. Many a fine horse has been ruined, and many a planter's collar-bone broken by the horse putting his foot through a rotten culvert or bridge. In a matter like this the old saying: "A stitch in time saves nine" is peculiarly applicable, especially if some of the ultimate stitching has to be done by the surgeon.

When the land alongside the road is a bit stony, the line of road may be trenched to the depth of a foot or so and the stones gathered from the cultivation buried there with a layer of earth on the top. This has been found by experience an excellent plan, and results in a splendid permanent road.

The stones can be buried in trenches on the two sides of the road, where wheel traffic may be expected to operate.

Marshy ground.

In carrying roads through marshy land, much difficulty has sometimes been experienced. Raising by earthing up is sometimes not sufficient, as the soil itself is of such a boggy nature, that no kind of treatment seems to render it solid in the rainy season. The most common way of dealing with such places is to use branches of trees laid across the road, or logs of wood, touching and continuous, covered with scme light brushwood and soil. A very simple plan is to use elephant grass, or even sun grass, laid across in the same way, and the result is a wonderfully firm road, with none of the roughness of the *corduroy* road, by which name the log system is known. The grass lasts much longer than one would think, because the very marshiness of the ground prevents it from rotting soon. The preserving qualities of mud are well known to the Bengali cultivators, who purposely steep their bamboos in muddy water for weeks or months before using them for buildings, which treatment causes them to last much longer.

Hill roads.

The making of roads for a hill- garden is much more difficult, and requires in some instances a great deal of skill and attention.

Gradient.

Main roads may be 10 feet or 12 feet wide, exclusive of drain, but ordinary garden paths from four feet to eight feet only. A good useful gradient is about ten degrees, or 1 in 6, and unimportant short cuts may be made as steep as 1 in 4.

Clinometer.

The "Self-registering Clinometer" which has recently been invented enables any planter to survey and arrange the alignment for new roads of any gradient without difficulty. Even before the jungle is cut, it is possible to

mark out the alignment accurately by the use of this instrument.

It should be borne in mind that the easier the gradient up hill, the longer the road, to a given poin above, and if the road seems too long, coolies will not use it, but will make a short cut.

Short cuts.

In important places it is advisable to build a permanent short cut of stone steps straight up hill, because no man on earth can stop coolies from making short cuts, when there is a great deal of traffic, and for this reason it is better to build a permanent one, which will not soon wear into a deep water-course, and carry away great quantities of soil from the cultivation.

Slope of roads.

The question as to whether roads should slope outwards or inwards has been much discussed, and gentlemen of great experience and ability can be quoted for either view. A combination of the two systems is found to work best. It is beside the question to argue that the water should be allowed to find its natural course, because when any one begins to make a road, he alters the natural state of things, and he further makes a very important alteration when he cultivates the land both above and below the road. Wherever a road winds downwards, from a hollow towards a spur, it may be made sloping outwards, because in such circumstances any water going from the road has a tendency to spread, owing to the round of the hill, rather than to concentrate. When a road has rounded the spur and is again leading in towards a hollow, it must be sloped *inwards*, and have a drain, because the continuously contracting character of the ground forces any water that falls to concentrate, and it must be so dealt with. Wherever a drain is considered necessary, the road must be made to slope *inwards*

Drains.

for the following reason : in the early stages of the monsoon it is not unusual to have a sudden

burst of very heavy rain after a spell of continuously dry weather ; some rubbish or jungle may have got into the drain here and there and been neglected ; the first burst of the flood comes rushing down the drain, gathering the rubbish in front of it until there is quite a heap being carried along ; this meets with some obstacle at a bend of the road, perhaps and finally forms a block, when the water bursts over on to the road. Now, if the road slopes *inwards*, this water will merely go round the block and back into the drain at a point further down the road, the only damage being a rut in the road, which can easily be repaired; but if, in such a case, the road slopes *outwards*, the water from the blocked drain rushes clean across it and down the cultivated land, resulting in havoc and destruction, more or less complete. Hence, it may be laid down as a definite rule, that when a road slopes outwards it must have no drain on the inner side

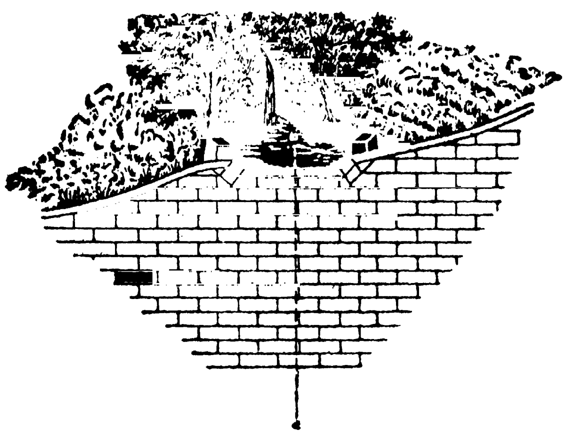


FIG. 6—CAUSEWAY AT MOUNTAIN STREAM.

The making of culverts or small bridges on hill roads should, if possible, be avoided. It is sometimes necessary to have a culvert

Culverts on hill roads.

for a drain crossing the road, but in every such case the culvert should be made *much larger* than is required for the normal flow of water. Culverts have a nasty habit of getting blocked with rubbish in a sudden flood, and then woebetide the road, and the land also if newly dug.

Outlets should be made for all drains at intervals as frequently as possible ; advantage can be taken of streams or of rocky jungle land for this purpose. It is dangerous to carry a drain for any great distance without a suitable outlet.

Crossing streams.

The crossing of small streams is one of the most important matters in hill road-making. No bridging should be attempted, The most efficient and permanent system is to build up a causeway from the bed rock, and let the water flow over it. Avoid anything like a contracting drain. Let the water *spread out* as much as possible.

When the chasm to be crossed is rather deep and wide, the building may be in the form of a causeway, leaving a basin on the upper side ; this takes less stone than building the whole thing up, and in time becomes fully as strong as if the whole basin had been filled up with stone. (See illustrations, Figs. 6 and 7.)

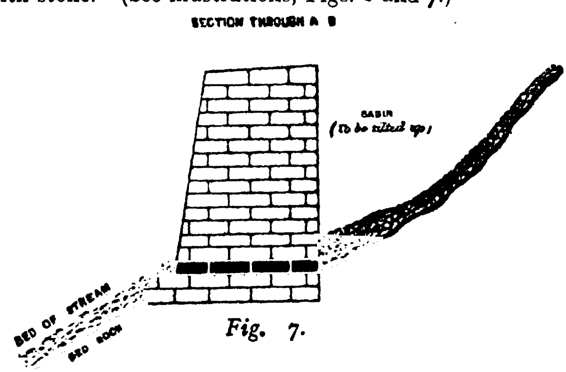


Fig. 7.

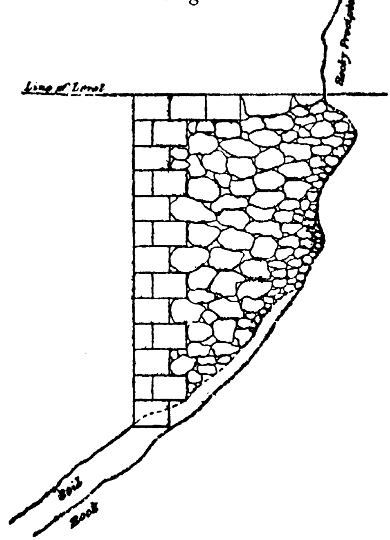
The water will at first flow *through* the wall, but as soon as the monsoon comes on, the first flood brings with it a quantity of stones and silt, which fill up the basin ; the water then flows over the top of the wall, as intended, and the building becomes firm and permanent, the basin full of silt forming a cushion behind it.

Such building work should be with dry stone only—no mortar.

Revetments.

Revetments are always more or less expensive and are often very unsatisfactory ; hence in road-making, it is advisable to avoid building, unless where absolutely necessary. Even when

Fig 8.



Faulty Revetment.

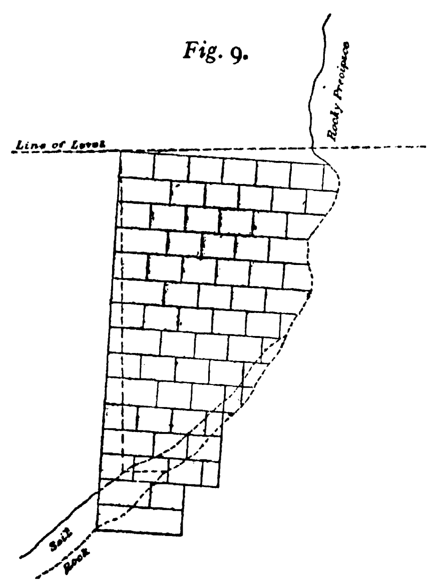
a landslip has carried away a piece of road, it is usually better to cut back into the solid ground for a new track,

rather than to build up in front. A roadway cut into soft rock is always much preferable to a built gallery sticking out from the hill-side. It may be necessary in many places to build a small revetment on the *upper* side of the road for such revetments, of course, a perfect foundation can be got on the road itself, and the work will give no trouble.

Slope of banks.

Earth banks everywhere should have a slope of *not more* than 50 degrees from the horizontal. Sometimes it is necessary to build a revetment in front, and in such cases a good deal of supervision is necessary to ensure good permanent work being done. The cooly is inveterately fond of building upon sand, hence the importance of seeing all the details of this work carried out on sound principles.

Fig. 9.



Proper form of Revetment.

The accompanying sketches show a revetment in section. Figure 8 shows how it should *not* be done, and Fig. 9 shows the proper form of building. The following points require attention :—

First.—There must be a good *foundation*, right down on the rocks, on which a bed sloping *inwards* should be cut. The manager or assistant should inspect the foundation after excavation and before a stone of the building is laid.

Second.—The face of revetment should be made to a slope or batter of about 1 in 10 from the perpendicular.

Roughly built revetments should slope 1 in 6.

Third.—The building should be in regular courses. The courses to be not level, but at right angles to the face of revetment.

Fourth.—The courses should be carried right back. Native workmen usually build a mere *veneer* of good stone, and simply throw in rubble behind.

Fifth.—Avoid filling with soil, which retains water, and becomes a source of danger.

Generally speaking, dry stone revetments are as strong as there is any possible need for.

Building with mortar.

If, however, good stone cannot be obtained, it may be necessary to use lime mortar in order to bind the small stones together. In such a case it is imperatively necessary to have *weeping holes*, to carry off any water which may get behind the building.

Weeping holes.

These may be 6 by 6 inch reaching right through the wall: they should be introduced in every third or fourth course, and about every four feet apart.

CHAPTER VIII.

LANDSLIPS.

Erosion of mountains.

THE natural condition of all mountains is one of more or less gradual erosion and diminution; portions or particles are continually being carried by the action of the elements down to the plains below, or away into the depths of the sea. The steepest portions of the mountain sides suffer most, both from the ordinary and somewhat slow action of wind, rain, frost, heat, and snow and from the sudden devastation wrought by earthquake or by cloud-burst, when it may be said that the mountains literally flow down.

Action of natural forces.

The ground is being constantly subjected to various nfluences which have a mechanical effect upon it, and prepare it for the direct action of water which eventually carries it off piece by piece. At the altitudes where tea gardens can be planted, very little frost or snow may be expected, but the ground is subjected in some measure to the influence of heat and cold which cause rocks, etc., to expand and contract alternately, and so tend to separate them: the air at the same time acts upon certain portions of rocks and stones, causing them to decay and become disintegrated, so that separation is easy. By far the most effective of the forces at work, however, are the changes of season from wet to drought, when the influence of a tropical sun penetrates to a great depth and extracts the moisture from both soil and rock; the immediate effect of which is a somewhat uneven shrinkage in bulk and a consequent loosening of the whole fabric. Sometimes great cracks or fissures are by this means formed in the ground, but more usually the whole

becomes permeated by a network of tiny fissures which communicate with one another, but which may not be readily noticeable. Soil of a stiff or clayey nature shows these cracks very readily, because they are always larger owing to its tenacious nature which prevents its being split up into small divisions. In every case the result is the same, however, when moisture has been carried off, an amount of space must be left behind, corresponding exactly to the volume of water displaced. The ground thus loses a good deal of its cohesiveness and becomes year by year more ready for the levelling forces of rain and flood.

Space left by moisture.

With the onslaught of each succeeding rainy season more or less of the land gets carried away to lower levels, or into streams and rivers; at the same time a great deal of water percolates into all the fissures caused by previous drought and softens all that is soluble, making it ready for any force which may be sufficient to detach any portion of it from the rest. When there is an excessive and continuous fall of rain, some portions of land which have previously become loosened get so saturated and soft that the whole thing is practically in a fluid state, and with the enormous added weight of water great portions commence flowing away to a lower level, carrying devastation and destruction in their course, and leaving a great scar on the mountain side.

Effects of rains.

Saturation.

It is not often that any very large area is involved in one landslip; only the looser portions of the land give way first, and the usual result of a specially severe deluge of rain is that the mountain side is more or less scored here and there by small landslips all over the steeper slopes. Sometimes, as in the case of the "Darjeeling Disaster" of 1899, there have been fully five hundred distinct landslips on

Darjeeling disaster.

as many acres of cultivation, and involving a loss or destruction of something like seven per cent. of the cultivated area.

When land has been cleared for cultivation, the natural condition of things is of course altered; the process of disintegration is somewhat accelerated, and the liability to slips is increased. The removal of forest trees or shrubs has a very direct effect in this way, as the land is no longer held together by their roots, and the latter, on rotting, leave channels in the ground for the inflow and dissemination of water.

Weight of water per acre.

Of the ultimate or immediate causes of landslips, the actual deadweight of water is the most important. As already stated, there is an enormous weight of water annually dashed upon the surface of the ground in the form of rain. Every inch of rain means a fall of 101 tons of water upon each acre of ground, so that in places where the annual rainfall is a hundred inches, each acre gets a weight of 10,100 tons during the season. It is thus at once seen that during a spell of unusually heavy rain, there is a very serious weight added to the soil, and a consequent impetus is given to any portion of land which may be ready to slip. It has been reported that during the time of the Darjeeling Disaster in 1899, something like 28 inches of rain fell within about forty hours, which means that during that short time each acre of ground had to bear a superimposed weight of fully 2,800 tons of water. It is not wonderful, therefore, that great portions of the hill-sides at the steepest places were carried away, and that the floods brought devastation also to the valleys below.

Surface drainage.

Surface drainage has naturally an important place in any efforts to protect the hill-sides from wash or from slips, and yet the most common cause of small landslips is not so much

want of such drainage, as drainage *misdirected*. When drains are constructed at all, they should be made to cope effectively with a good deal more than the ordinary flow of water; they should be capacious enough to carry off easily the largest flood which has ever fallen upon the land. The runs should be short, and the openings into streams or masonry drains as frequent as possible. All main drains and all drains with a steep gradient should be of masonry with ample capacity. The openings or debouchings of drains are of the greatest importance; sometimes they are made to deliver their water simply upon a piece of somewhat level land, which, in ordinary times, answers very well, but when a long spell of very wet weather takes place, this land gets exceedingly overloaded with water and the water soaking through the ground bursts out unexpectedly at some point lower down, thus causing a landslip. Sometimes the simple rush of water at the outlet of a drain cuts into the soil in such a way as to undermine the land around it, gradually gathering force and impetus, until in the course of a few hours the rut which has been formed presents all the features of a scar resulting from a sudden landslip.

Main drains.

Occasionally a landslip takes place in the midst of a patch of tea where the land is fairly level, and at a place where such a thing is least expected; no drains being anywhere near and no cause whatever apparent. In such cases the slip is usually caused by a natural cavity in the hill-side, which has become filled with water soaking down from above and so becomes an underground reservoir; the gradual decay of rock, or the operation of other forces described above, eventually makes a small opening communicating with the cavity, through which the pent-up volume bursts, tearing away everything in its course until the reservoir is thus drained away.

Natural cavities.

However desirable it may be that the soil of a tea garden should get all the benefit possible from the manurial properties of rain water passing through it, it is of much more importance that the soil itself should be retained, and so both surface wash and landslips must be guarded against by ample and efficient surface drainage, giving every facility for all excess water being got rid of as rapidly as possible.

Excess water.

In making a new garden which requires to be terraced, or in terracing an old piece of tea, terraces should never be made too prominent, for several reasons : if very prominent they are then too easily broken down ; they are exposed very much to sun and wind, and hence in dry seasons the bushes will suffer severely from drought ; but the most important reason is that if they stand out perfectly level, they hold too much water during excessively heavy rain ; the immense weight of the sodden soil makes them sometimes bend forward and crack at the back ; there is then a rush of water into the subsoil, and down some fissure amongst the loose rubble between the soilcap and the bedrock, the consequence being a landslip, more or less serious.

Prominent terraces.

The measures to be taken to repair damage by landslips are of two classes : the recovery or replanting of lost or damaged areas, and the proper dealing with hopeless slips so as to prevent their increasing in area or undermining other portions of land.

Repairing damage.

When a patch of tea has been simply overwhelmed or obliterated by a slip from a hill above, it may be possible to recover a great portion of it by carrying off the excess soil for use as top-dressing to poor ridges in the neighbourhood. After the Darjeeling Disaster, a considerable area of tea was recovered in this way, and in some instances bushes

Resuscitating bushes.

were resuscitated after having been buried under a depth of several feet of earth and stones for four months; they were then very heavily pruned, and the growth came away splendidly, the bushes being in a few months as good as ever.

Cracks. Sometimes cracks or fissures appear as a result of a plot of land partially slipping or settling down. All such cracks should be filled up and rammed as tightly as possible; if left alone, they will form channels for the inflow of water to the subsoil, and the land is almost certain to slide away during the next heavy burst of rain.

Replanting. If the accumulated soil is too deep for carrying away, it may be dug over like new land, cleared of stones, etc., and replanted. The soil at the new surface may look very poor, being partly subsoil from the hill above, but there is a double depth of good soil underneath, and in course of time the new patch of tea will be better than anything in its neighbourhood.

On slips from which the surface soil has been carried away, and only subsoil left, the advisability of replanting is very doubtful, but if there is still remaining some admixture of surface soil as well as some good subsoil, the replanting may be done with advantage, more in order to keep the plot of tea complete than for any profit likely to accrue from such cultivation. If the future yield will be sufficient to pay for their upkeep, it is better to have such patches under tea; because little patches of jungle here and there amongst the cultivation are a great source of trouble and loss in measuring up tasks, and in that the jungle seed from these patches gets blown into the tea all around and continually generates troublesome weeds.

Scars. No attempt should be made to replant with tea any deep scars from which all soil of a productive nature has gone.

Any attempt of the sort can only result in complete failure.

Planting forest trees. There are certain kinds of forest trees and shrubs, however, which thrive upon such situations, and may be planted with success, such as the *Uttis*, the *Saur*, etc. All coniferous trees, such as cryptomerias, pines, etc., are fond of sandy soil and can be made to grow on scars left by landslips. Bamboos also grow well and bind the soil splendidly. Before planting these places, the unevenness of the ground should first be smoothed a little, and the seeds or plants put at proper intervals, the spaces between being planted with shrubs, such as *totni*, *sisnu*, etc. Any kind of grass that will grow, should be encouraged.

Protective works. Sometimes it will be found that at the head of a scar the hollow is so deep as to undermine a piece more of the land above it, which thus becomes in danger of slipping at some future time. It is, therefore, advisable to build a stone revetment at these places, both in order to prevent another slip, and to prevent the tea immediately above from exposure to drought. This can, however, only be done if there is an ample supply of stone near at hand; otherwise the benefit would not be worth the expense.

Gorges. Excessive rainfall, accompanied by landslips and local floods from water which has been temporarily dammed up, occasionally alters entirely the character of the bed of a drain, so that what was before a tiny rivulet on the surface of the ground is now a deep gorge with very steep sides, the water cutting deeper and deeper and the sides continually falling in, resulting in ever-widening damage. If in such instances the stream has found the bed rock, the area of loss cannot greatly increase, but if only still flowing upon loose stones and sandy soil, it is sure to

increase further, unless measures are taken to make an artificial bottom. This can be done by building roughly with large stone slabs, if they can be had ; these should be made in the form of steps, with side walls to keep the banks from falling in.

Deep drains.

This work also must be restricted to the amount possible to be done in the circumstances, and the expenditure of labour upon it will be justified only if the property to be protected is worth so much. When buildings are in danger from a condition of things such as this, the expenditure will probably be amply justified and, after all, it is wonderful how cheaply and efficiently such work can be done by ordinary coolies, with a little careful training.

Wooden troughs.

Wherever stones are not available for this work, a wooden trough may be made for the bottom of the drain at comparatively small expense, and will probably last until the ground becomes consolidated and till the steep banks can be covered with a growth of trees, shrubs and bamboos, etc., to bind the loose soil together.

CHAPTER IX.

MANURING.

UNTIL recent years, the question of manuring for tea did not receive much attention from planters in India. Its importance is now recognised on all hands and manuring programmes are the order of the day. It is a subject which deserves earnest and scientific study, because so much money can be wasted or saved, as the case may be. The need of science is very urgent ; not so much from an academic point of view as the scientific application by the planter himself to the tests of his own experience.

The Scientific Department of the Indian Tea Association has already produced several important pamphlets on this subject while dealing with the Tea Soils of Assam, Cachar, etc. The work on "Green Manuring" by Dr. Mann and Mr. C. M. Hutchinson is particularly valuable. There is still much room for study and experiment, however, and a great deal of valuable information will no doubt result from the work now being done at the special experimental stations.

It is unfortunate that the Scientific Department had to abandon the Experimental Station at Heleaka, upon which so much had been expended, and from which so much useful information had been expected.

The most important department of this subject is that with reference to manuring for *quality* in the teas produced. If any advance can be made in this direction, the results will be of far-reaching importance to the industry.

In order to understand the composition of the tea plant, let the student suppose that an entire bush is taken up by the roots It is chopped into suitable small pieces and weighed, then carefully dried in an oven till all the moisture has been evaporated. Reweighment will then indicate that more than half the original weight has disappeared. The material gone was water, which was decomposed by the heat, and has entered the atmosphere in the form of hydrogen and oxygen gases.

Composition of tea plant.

Of the dry material which remains, more than fifty per cent. is carbon. This also can be transformed into gas by setting fire to the material. If some moisture remains before the burning, or for any other reason the combustion is not efficient, there will be more or less of smoke and soot emitted during the burning, which means that a portion of the carbon is not consumed. It is carried away with the ascending gases as an impurity in the atmosphere. If, however, the process is conducted in a suitable oven, where the materials can be treated on a red-hot plate and a plentiful supply of oxygen admitted, the combustion will ultimately be complete, and only a small quantity of ash remain. With the exception of that tiny pile of ash, the whole of the tea bush has disappeared. Nothing has gone out of existence. The material has been turned into gases and added to the atmosphere as hydrogen, oxygen, carbon and nitrogen. These materials which have now become part of the air are commonly known as the "organic" portions of a plant. They are now, however, more correctly described as the "volatile matter."

Volatile matter.

The little heap of ash contains the "Mineral Matter" of the plant, and includes potash, phosphoric acid, lime, magnesia, iron, silica, etc., in various combinations, and mostly in

Mineral matter.

minute quantities, the total ash weighing not more than about one or two per cent. of the original bush.

The contemplation of these facts gives one a new conception of the relation between the earth and the atmosphere ; also the important part which the latter plays in sustaining and nourishing animal life. Every instant of a man's life he is inhaling from the atmosphere large quantities of gases and, without conscious effort on his part, his lungs are selecting the oxygen which his body requires, and returning to the atmosphere the carbonic acid gas which he does not need. At the same time, during the hours of daylight, the plants which are growing to provide food for him are also inhaling the almosphere, through the medium of their leaves ; these also possessing the power of selection are retaining the carbonic acid gas and returning the oxygen to the atmosphere, together with hydrogen. All the elements or materials abovementioned are present in earth or air in quantities which are abundant and inexhaustible.

Objects of manuring.

The object of manuring, added to cultivation, is to stimulate our plants, and at the same time to place within their reach additional supplies of the food which is necessary for building up their structure. The present position of our knowledge is that after much scientific study and research, both in the laboratory and the experience gained in the field, the experts have been able to announce certain simple and well attested facts for the general guidance of agriculturists. It has been established that the following materials are indispensable for growing plants. The *volatile elements:* carbon, hydrogen, oxygen, and nitrogen ; also the *mineral elements :* phosphoric acid and potash. Small quantities of certain other materials are also necessary, but those are always present in

Elements.

sufficient available quantities in every agricultural soil.

The first three of the elements named are not required to be included in any scheme of manuring, because they are collected by the plant itself, and are supplied by natural means. Water is, of course, necessary in sufficient quantities for root growth. It is also volatile matter, being composed of hydrogen and oxygen.

Carbon.

It is an interesting fact that although carbon bulks largest of the solid materials of any plant, especially in the woody parts, it is not taken from the soil, but derived directly from the atmosphere by the leaves in the form of carbonic acid gas, as already mentioned. The gas is transformed within the plant itself into suitable plant tissue.

Nitrogen.

As regards the mineral elements, the phosphoric acid required by the plant is small in bulk. The same may be said of potash. The remaining element which we have mentioned above is *nitrogen.* This is the most important of all the substances from a manurial point of view. The world supply of it is so vast that it forms four-fifths of the whole atmosphere, and yet it is so fugitive in this form that only very limited quantities can be extracted from the atmosphere by manufacturing methods for the purpose of manure. It is present, however, in considerable quantities in all organic matter, as well as in the soil and in the rocks which contain the prospective supplies of soil for future generations.

Nitrogen may be considered the foundation of all systems of manuring, but a good deal depends upon the form in which it is applied. It cannot be administered pure ; hence for commercial purposes it is sold in combinations more or less strong. In the form of nitrate of soda it is most active and most easily solvent ; but this fo m is not usually advisable for a tea estate, for

various reasons, particularly because the permanent nature of the tea bush indicates the avoidance of irregular growth in spurts. For a steady supply of this element, sulphate of ammonia is a good form. Nitrate of potash is also advised. Much depends upon available supplies and relative costs. The latter material combines also a supply of potash.

Potash can be obtained in separate form as muriate of potash, kainit, or wood ashes ; the latter containing also some phosphoric acid.

Phosphoric acid can be had in the form of super-phosphates, ordinary or concentrated, bone meal, or bone ash, mineral phosphates and basic slag. The mineral phosphate is simply phosphatic rock, ground fine, and is so slow in its action as to be almost negligible. Basic slag is a most valuable manure. The only drawback is its heavy weight, in comparison with superphosphates. It is a by-product in the manufacture of steel by the bessemer process. It is the scum from the furnace ground down very fine, and is largely composed of lime, which has been used to extract the phosphorus from the molten metal. It is regarded as a mixture of lime and phosphoric acid, and possesses the qualities of both in a high degree. It is specially useful on stiff soils.

Scientific Department.

Manure merchants also supply the primary elements in a great variety of combinations with natural or artificial manures, from which it is very difficult to distinguish and select the article most useful and economic in particular circumstances. The Scientific Department gives special attention and assistance on the subject of manuring to all estates in membership with the Indian Tea Association, and can give valuable help in selecting and arranging a system of manuring to suit any particular portion of an estate.

One fact which has been proved by experience is that oil cake, in the form of castor meal or soya bean meal, is extremely valuable wherever the cost of transit is not too high. Mustard meal is not quite so valuable. The meal is an organic material, containing all the virtues of a complete manure, together with the advantage of additional organic matter for the soil ; also the certainty that together with an increase of crop there is no fear of any falling off in the quality of the teas produced.

Oil Cake.

Wherever the position of the garden to be treated is such that the carriage of manure is difficult or expensive, it is desirable to adopt the more concentrated forms of purely chemical manures. In all cases it is well to be content with materials and quantities of a moderate character, and to avoid pressing the soil to such an extent as to deteriorate its value for cropping during succeeding years. Landlords in England are now protected by law against any farmer who proposes to adopt methods of treatment which are calculated to reduce the fertility of the soil ; also the farmer, when giving up a farm, is entitled to compensation on a proper valuation for any improvement in fertility which he has effected.

Deterioration.

It is a recognised fact that soils can be temporarily impoverished by certain methods of intensive cultivation, by excessive quantities of chemical manures, or by excessive dressings of lime ; because the humus and organic matter in the soil may be dissolved, and used up too rapidly, or the latent supplies of mineral elements necessary for plant life, depleted more rapidly than natural forces are able to replace them from decayed rocks and stones. The principle underlying any system of manuring should be to feed the soil—not to deplete it. The true manuring is fertilization.

Proportions.

It has been proved in actual experience that there is a definite relationship in the proportions which any plant requires of the three elements already mentioned; nitrogen, phosphoric acid, and potash. If there is a deficiency in the soil of any one element, it is useless to supply abundance of the other two. The growth of the plant is limited by the element in deficiency. Any surplus beyond the proportion required is waste, and may, if supplied in superabundance, even prove deleterious to the plant. As a rule, all three elements are necessary; but the proportions most suitable for any block of land cannot be accurately determined, otherwise than by careful experiment on the spot. In the early days of manuring tea in Assam, a great deal of money was thrown away upon misdirected efforts. In some cases, the quantities of chemical manures used were quite fantastic; as, for instance, one garden where superphosphate was applied at the rate of nine maunds per acre, without any other element added; or another plot where sulphate of potash was applied alone at the rate of one and a half hundredweight per acre. The record of such experiments mentioned by Bamber * provides food for reflection.

Chemical mixtures should be stored separately until immediately before application. If previously mixed and stored in bulk there is a tendency to effervescence, in which case a good deal of the nitrogen is released and lost.

Application.

When applying manure, it is a good plan to provide each of the operatives with a measuring basket, or box, capable of holding exactly the quantity determined upon for each strip of land. The overseers then only need to see that the material is evenly distributed. It should be

* "Chemistry and Agriculture of Tea" by M. Kelway Bamber, 1893.

broadcasted on the land, between the lines of tea, and should be mixed with the surface soil by means of a light digging as soon as practicable.

Artificial manures.

The application of concentrated manures on a lavish scale is not generally advisable, because they may have a tendency to impoverish weak soils by forcing them to part with some of their constituents prematurely or too freely. No manure of this kind should be used on a large area without first making sure that it is suited to the soil of the particular locality, and it will often be found that what may suit one part will not suit another part of the same estate.

Farmyard manure.

On most estates there is a little manure available from cows, sheep, goats, pigs, etc., in the possession of the coolies and others. This should, of course, be carefully conserved and used for the poorest plots of tea within reasonable distance.

Manure pits.

All cattle manure should be preserved in pits with as much dry jungle as possible, and covered from the influence of sun and rain. It is questionable whether it may be wise to allow any large number of cattle on an estate merely for the sake of getting the manure, because of the incalculable damage to forest resulting from the grazing of cattle, and because of the small results usually obtained in the way of manure.

Wherever the cattle are stall-fed, the position is very different; provided that the whole of the manure in such cases is made available for the tea plantation. An important consideration is that the value of the manure fluctuates very much according to the nature of the food given to the cattle. If they are fed largely on grain and root crops, or on oil cake, the manure is much more effective than when the food is only grass and leaves of trees.

Over the greater part of India it has been the custom from time immemorial to use cattle manure as domestic fuel; hence the agricultural classes generally do not seem to understand the value of the material as manure.

Manure per acre.

Mr. Bamber reckons that it takes 10 to 20 tons of cattle manure to an acre in order to obtain real or lasting benefit. Dr. Mann also puts it at ten tons. This is a large quantity, especially as many planters are doubtful as to whether its benefits extend beyond one year or two years at most.

Cost of transit.

In all details of manuring, the cost of transit is an all-important item, especially as regards bulky manures, and for hill-gardens this usually renders their application inadvisable. It has sometimes happened that manure has been brought from a distance at very considerable cost to gardens which were really suffering from want of cultivation, and the money would have been much better spent in giving a more deep and thorough digging to the land.

Manurial terms.

In connection with manuring there are various terms and expressions which are descriptive of the soil to be treated, as well as of the materials used.

Natural Manure is taken to mean materials which have not undergone any special treatment with a view to rendering them less bulky for transport or less offensive in handling.

A very common expression for such materials is *Farmyard Manure*, although in many instances the stuff referred to may never have seen a farmyard; but it is held to be descriptive of any bulky manurial material in its natural state, including excreta of animals and birds, together with vegetable rubbish of all sorts. Natural manure also includes the refuse of certain manufactures, including wool, cotton, hide, and other industries.

Artificial Manures may be reckoned to include chemicals, but are usually taken to include also natural manures which have undergone special treatment or preparation. To this category belong *Animal Meal, Dried Blood, Fish Manure, Bone Dust*, etc.

Organic Manures, or organic matter, includes any or all of the above, and is applied to all material formed by animal or vegetable life, including all *debris* of such life in any state of preservation or of decomposition.

Humus.

Humus is organic matter which has been broken down into a more or less complete state of decomposition; this having generally been brought about by bacterial action. This action is greatly facilitated when the organic matter is mixed with soil near the surface of the ground. Humus is generally dark in colour. It is sometimes described as *vegetable mould* and it is material in a condition such that it can readily be absorbed by plant life into plant growth.

Peaty Soils contain a large proportion of organic matter which has not become converted into humus; either because of an excessive quantity of water constantly in the soil, or because of acidity. Suitable drainage, with the addition of lime, soon develops remarkable fertility in such soils, as the organic matter rapidly becomes converted into humus. Besides being a direct manure, humus renders stiff soils more open, and renders light soils much more capable of retaining moisture.

The chief objection to the system of clean weeding which used to obtain so largely in Ceylon was that the practice tended to eliminate humus from the soil. Every time that a crop of jungle is dug into the soil, an important addition is made to the humus content. A great part of the value of green manuring consists in its large formation of humus.

Chemical Manure refers, as its name implies, to substances without organic life, but consists of the materials with which animal or vegetable life is associated, and which are necessary for the existence of such life.

Chemical Manures.

Chemical Analysis of any soil is a help towards ascertaining what manures, and what proportions, are likely to prove suitable; but such analysis is not by any means the sure guide which some persons are apt to assume. The tests applied by the chemist in his laboratory reveal the presence of whatever plant foods may be in a sample of soil ; but these tests cannot always discriminate as to whether, or in what proportions, these foods are present in an available form. This is so notorious that it is now generally recognised by competent authorities that the real and ultimate test is by practical experiments in measured fields or plots. The chemical analysis of a sample is only a general guide regarding the materials, or the proportions of materials likely to prove most successful in the practical field experiments.

Chemical Analysis.

Experiments.

When any one contemplates the adoption of a system of manuring for any particular crop, he should proceed systematically, and first find out by working on a comparatively small scale, whether the larger scheme is going to pay. It is so easy to waste money in the application of any substance which may already be present in abundance in his soil, or in applications which may so reduce the quality of his production as to render the increase in quantity quite useless from an economic point of view. In some situations the cost of carriage to the spot may render a manure which is otherwise suitable quite out of the question.

The matter of climate is also of importance. In a forcing climate a certain application might ensure an

increase of three maunds of tea per acre, whereas in a more temperate climate the same application would not be capable of producing more than one maund, and would not pay.

Manuring young plants.

The manuring of young infillings in old tea, and of delicate plants, is always desirable, in order to bring them up to the general standard of the block.

A general rule to be observed in manuring tea is that, wherever there is a strong labour force, and intensive cultivation carried on, no application of chemicals is advisable; because the soil is already being stimulated sufficiently by frequent turning over. In such circumstances organic manures are most likely to prove beneficial. Green manuring also, with suitable annual crops, would in such circumstances provide a good supply of organic matter to enrich the soil with humus, and to improve its tilth. In circumstances of the opposite extreme, where labour is so scarce as to be unable to deal properly with jungle growth amongst the tea, it would be folly to spend money upon manuring, the first result of which is an increase of jungle growth.

Soils.

In the classification of soils there are various terms in use, although the actual classification is quite simple, and the grading is according to the average size of the soil particles. *Stiff clay* refers to a soil in the finest possible state of division. If a sample of clay soil is taken and thoroughly mixed into a basin of water, the portion which is held in temporary suspension in the water is clay, while the sediment which immediately sinks to the bottom is the proportion of sand. Clay soils are very slow in absorbing water; but when saturated, they contain more water, bulk for bulk, than any other. They are also very retentive, and with a good system of drainage can longest withstand a season of drought.

Most clay soils are agriculturally rich, especially in potash. Soils of this class are called " heavy," because they are sticky and heavy to work.

A *Clay Loam* contains a fair proportion of sand, and when well drained, is generally a good soil for tea. It requires plenty of cultivation. *Loam* represents a soil of medium texture. A dark-coloured loam is generally rich in humus. It is easy to work, it rapidly responds to favourable weather conditions, and to light cultivation.

Sandy Loam is liable to suffer from drought. Its usefulness for tea depends to a large extent upon the character of the rainfall, which suits best if showers are frequent, and not very severe at any one time. On a hill country, a sandy loam must be terraced as a protection against the onslaughts of heavy rain. Green manuring is always highly beneficial to such soils.

What is termed *Vegetable Mould* generally contains 5 to 20 per cent. of humus. *Peaty Soil* contains a large proportion of organic matter, sometimes as much as 50 per cent. This explains why it is that on some of the old Bheel gardens of Cachar and Sylhet, there are considerable areas where the whole surface of the land is now 9 or 12 inches lower than the original level. As the organic matter got used up in process of tea cultivation the land subsided.

Lime.

Lime is not considered a direct manure, but it occupies an important place in connection with manuring. In certain circumstances its application is absolutely necessary. In some soils it is present in abundance. Its principal usefulness is to correct acidity. A soil may be very fertile with scarcely any lime in its composition, provided it does not suffer from acidity. Bamber has pointed out that magnesia in a soil is a very efficient substitute for lime. Acidity in soils can readily be discovered by

testing with litmus paper, a little booklet of which can be obtained from any chemist's shop. A leaf of this paper has merely to be covered with soil in a wet condition. If the paper immediately turns a bright red colour, the presence of acid is indicated. Lime is generally very useful on stiff soils, because it causes flocculation of the particles of soil.

In practice it has been found that frequent applications of manure, especially farm yard manure, tend to render the soil acid, and heavy dressings of lime become necessary once in every few years. Once in nine years is the practice in general farming in some parts of England. One ton of lime per acre is considered a fair dressing but in some instances from 3 to 10 tons have been applied.

In one respect there is a danger involved in overdosing with lime. It decomposes organic matter very rapidly, sometimes giving quite phenomenal crops for a few years, with very bare years to follow in consequence. This fact has been the origin of the saying amongst farmers that " Lime enriches the father, but impoverishes the son."

In India, *Lime* is found in the form of limestone, known as *Carbonate of Lime.* This is the simplest form of lime for agricultural purposes; only that it must be ground into a very fine powder before use. In this form it has no caustic action, and it may be applied in large quantities without fear of its unduly dissolving the humus, or of its hindering nitrification in the soil; but at the same time its beneficial action is very slow. This lime is most suitable for heavy clay soils, provided it can be applied in very large quantities, such as 5 to 10 tons per acre, because of its mechanical as well as its alkaline effects upon such soils; but it is obvious that the cost of carriage of such quantities, added to the cost price, makes it impossible to go in for this at any considerable distance from the source of supply.

Quick Lime or *Oxide of Lime* is obtained by burning limestone until red hot, when a large quantity of Carbon Dioxide becomes liberated, with the result that 44 out of every 100 lbs. disappears, leaving a residue of 56 lbs. of pure lime or *Oxide of Calcium,* provided that the limestone has been of good quality. This is the form in which lime is used most largely by farmers when their farms are distant from the lime quarries. This unslaked lime is placed in little heaps upon the ploughed fields, to weather down, before being distributed evenly over the surface. It gradually absorbs water from the atmosphere, and becomes a powder. It is then *Hydrate of Lime,* or what is known as *Slaked Lime.* The same change can be made, however, in a few minutes by the addition of water. In this process the stones have merely to be placed in a heap upon the ground, and a quantity of water, equal to about a third of the weight of the lime, poured over the heap. In a few seconds, the stones begin to get hot and to emit steam, finally falling down into a fine white dry powder, weighing about one-third more than before. This is the most active and useful form of lime.

A very important consideration for any one contemplating the use of lime in large quantities is the difference in weight between what may be called the raw limestone and that of quicklime, especially where carriage is costly; also the importance of purchasing pure lime, so as not to be obliged to pay for carriage of large quantities of impurities, such as sand.

When quicklime is exposed to the action of the atmosphere it cannot be kept in its caustic state for any length of time. It rapidly absorbs water from the atmosphere, especially if the weather is damp, and so becomes *Hydrate of Lime* and in course of time reverts to a practically insoluble condition, as *Carbonate of Lime;* the natural condition in which limestone is found.

This is the condition of much of the material which is sold in the Indian Bazaars as freshly slaked lime. It has been kept over from one year to another, and a large proportion of it has become insoluble. It is of but little use for buildings, but could be useful for agricultural purposes as *Carbonate of Lime*.

As a rule, sandy soils require very little lime.

How to apply manure.

In applying manures it is very important to note that the manure should not on any account be heaped around the collar of the plant. There are no feeding roots at the collar. The feeders are at the extremities of the root branches, and the manure should accordingly be laid in the spaces between the tea, and dug in there. The sooner it is dug into the ground the better.

Killing by manure.

Instances have been known of tea bushes being actually killed by fresh manure heaped round the collar. The manure fermenting caused the bark of the bush to *rot*, and of course as soon as a complete ring of bark on a tea plant is destroyed, the circulation of sap becomes impossible, and the plant is soon dead.

Rubbish and thatch.

Planters generally do not realize the value of the rubbish which gathers in the neighbourhood of cooly lines. Instead of burning this, it should be applied to the neighbouring tea; the cost of application is trifling, and the results very satisfactory.

The most valuable manure to be had on a tea estate is the old thatch from the cooly lines. This is usually carried off to the jungle or is burnt to get rid of it. This is a *very great mistake*. The thatch is saturated with soot, and if it is buried or even simply thrown upon the ground amongst the tea bushes, the result is quite marvellous, in the free flushing and generally improved health of the bushes.

Wood ashes.

Another neglected manure is the wood ash from furnaces in the factory, which is usually considered a nuisance and is thrown out in heaps, sometimes piled up at the edge of the tea cultivation, where the excess of potash, etc., actually kills the bushes. Many thousands of maunds of wood are consumed in some factories annually, and the whole of the ashes literally thrown away, which might be of great value if distributed over the surface of the soil. The residuum of ash from each thousand maunds of wood is about 18 maunds, a much larger quantity than is generally supposed.

Prunings as manure.

The question as to whether prunings should be buried has been dealt with under the head of cultivation, and it may be again pointed out here that the value of prunings as manure is enormous, especially if buried deeply and buried in a green state. Any planter should hesitate very much before burning and destroying a matter of such value, especially if he has no means of replacing the materials thus dissipated into the atmosphere.

There are many estates where artificial manuring is never likely to pay because of the cost of transit, etc., and in such circumstances it is the more necessary to make the very best use of the materials to hand. Where manure is scarce or expensive, it can be used only for the weaker plots or patches of tea. It is often advisable to treat only individual *weak bushes* when there is not enough to go round.

Fungi on prunings.

If prunings are dug up after having been buried for some time, they will usually be found to have various kinds of fungus attached to them, similar to all kinds of vegetation in process of decay. These fungi must not be confused with the dreaded *thread* blight, which is of a different nature. Sometimes thread blight has disappeared from a block

of tea after heavy pruning, although the prunings were all buried.

Green *versus* Dry.

Vegetable matter is of much more value when buried green than after it has been allowed to dry; because much of the ammonia and other valuable material goes off into the atmosphere in process of drying above ground.

Mulching.

Mulching is the term which is used to denote the spreading of leaves and other vegetable litter upon the surface of the ground. There are circumstances when it is undesirable to break up the surface of the land, and mulching is the only means by which green manures can be used. Used in this way, the manure is not nearly so valuable as when buried, but it is still of great use, and particularly so in the hot dry season, when poor plots of tea can by this means be greatly protected from the severity of drought, and the material as it rots becomes a manure of much value. The one danger is from fire, and this is a very real danger in these days when the smoking of cigarettes has become so prevalent amongst the labour force.

Jungle stuff.

On hill estates, where the cultivated land is more or less cut up by ravines and jungle, a good deal of green manuring can be done with stuff from the jungle itself when labour is plentiful. This can be used either as a mulch, or for burying in trenches. Where thread blight is present in the jungle, mulching is perhaps dangerous; but when buried in trenches there need be no fear. The digging of the trenches has to be done first, then the jungle carried

Trenching.

and filled in, then covered over again with the soil. This is a very expensive work, however; it has been found that the cost of digging trenches two feet deep every alternate line has been as much as twelve to fifteen rupees an acre. When to this has been added the cost of carrying the jungle and

burying it, the total is not much less than twenty rupees per acre. The work is very thorough, however, and is recommended for estates where there is an excess of labour at certain seasons of the year. It is of immensely more value than digging and re-digging land which is already in a perfect state of cultivation. The addition of green material from the jungle is of the utmost value to the soil; providing as it does a new supply of organic matter, in the very best form in which it can be added to the earth.

Leaf mould.

Some planters are not aware of the remarkable difference in manurial value between leaves and rotten wood. It is a fact well known to gardeners that leaves and leaf mould have an enormously greater value than decayed woody fibre. Let any one try the difference with two flower-pots; one filled with rotted leaf mould, and one with thoroughly rotted trunk of a tree. Any flowers which may be planted in the former will grow with great luxuriance, while those planted in the latter will hardly be able to exist at all. The practical application of this is that no heavy sticks should be brought with green stuff from the jungle for mulching or trenching purposes; these only tend to encourage white-ants, while doing very little good in any case as manure. Of course, woody fibre does some little good, especially in stiff soil, which it helps to render more open and permeable. For similar reasons, it is very desirable to bury all light prunings; but after heavy pruning, the coolies should be encouraged, if possible, to cut up and carry away the heavy wood, after which the light stuff can be buried in the usual course.

Adhatoda Vasica.

Mr. Bamber strongly recommends the use of the leaves of *Adhatoda Vasica* as manure. They are rich in nitrogen which is one of the most important elements of food for the tea-bush.

The use of these leaves might also fortify the bushes to some extent against many of their natural enemies. An infusion or emasculation of the leaves of this plant is said to be an efficient insecticide against several insect-pests.

Top-dressing.

There is no means of improving poor land so sure or so permanent as top-dressing with new soil. This is a matter which in the past has been very greatly overlooked, and even at the present time there are very few persons who realize its full importance. It is many years since it was first observed that any mixing of soils tends to fertility, and that even in the case of two good soils of a different character, a mixture of the two will give a better result than either of them singly. This is said to be due to the different soils having been formed from the decomposition of different strata of rock, so that a mixture results in a more perfect combination of nourishment for plant life. Besides this, it has been found that mere mechanical differences render a combination beneficial : thus, a stiff soil is always benefited by the admixture of sandy soil, or sometimes even of pure sand, while a sandy soil is benefited by some soil of a closer texture.

Mixture of soils.

Improving poor land.

The great problem for many tea gardens, especially in hilly country, is how to improve worn-out land, or to replace soil which has been actually carried away. There are many gardens which have patches of naturally poor land between blocks of good tea, and it is not desirable to sever the connection by abandoning the poor patches. In all such cases, it is possible to transform the poor land into rich fields if there is jungle within reasonable distance from which surface soil can be extracted.

To invigorate poor land, manuring is but a temporary expedient, as all manures are more or less

evanescent ; whereas to top-dress thoroughly with good soil means changing the nature of the land and so effecting a permanent benefit. If really good soil cannot be had for a dressing to bare ridges, it is of course better to use poor soil than none at all, but the idea that any kind of soil will do is to be guarded against, because it is ten times better to go double the distance for rich soil than to be content with mere sand and stones, because it can be applied cheaply. It is worthwhile remembering that when one's land has been heavily top-dressed with poor soil, it is impossible to do the work over again with good soil at some future time, because the roots are already sufficiently covered, and if the covering is carried to great excess, the plants will be suffocated and strangled.

Strangling with soil.

Depth and cost per acre.

The depth to which top-dressing may be done with advantage varies with circumstances, and where there has been great wash, perhaps as much as a foot deep or more will be required. Under ordinary circumstances, it is necessary to dress to a depth of eight inches ; this, when it settles down, will become something like six inches all over, and experience has proved that such a dressing has an immediate and permanent good result upon the tea. A covering of six inches deep all over means something like 650 tons to the acre, and of course represents a great deal of labour, but if the work is done by task and the soil not very distant, it can be done for Rs. 60 to 80 per acre. Hill-gardens are usually much cut up by ravines, and pieces of very steep or stony land, which are unsuitable for planting, can yet be made to yield enough soil for this purpose. On some estates a good deal is saved under this heading by the use of wire tramways, but on almost all estates there is some time of the year when labour is in excess of the requirements, especially in the dry weather after cultivation has been completed and leaf is scarce. It is at this time that a

Wire tramways.

very large staff of coolies may be employed at this work, and infinitely better employed than in merely stirring up ground which is already in a high state of cultivation.

Some Assam planters have for several years gone in very largely for this work of top-dressing, and find it most remunerative and satisfactory.

Light railways.

Light railways have been brought into requisition when there is no leaf to carry, and, running all day, can deliver in the course of a month or so, many thousands of maunds of soil. One gentleman has for years used, during the cold weather, a steam engine for pumping the water out of "hollows," and he then gets access to a deposit of rich black mould, several feet deep, for use on his tea land. It may be observed here that not all of the "hullah" soil is of the same class, and to take stiff dead clay for top-dressing tea lands is worse than useless.

Some planters think that they are top-dressing when they apply a mere sprinkling of soil, but it must be observed that, in order to be thoroughly satisfactory, not less than 500 tons must be applied to the acre.

Combination top-dressing.

In some places it may be that there is abundance of green scrub to be had, but very little soil of any value; in these circumstances a combination of green manuring and top-dressing may be found most advantageous. First the scrub and grass, etc., in the jungle is sickled and then carried together with all dead leaves and decaying vegetable matter which can be swept up; this is spread on the ground under the tea bushes. A separate gang of coolies then carries enough soil to cover the whole. By this system a little soil goes a long way, and the green stuff, besides protecting the ground from drought for the time, becomes itself a valuable manure, especially for stiff soils.

Quality.

The efforts made to find a manure for improving the quality of tea have hitherto only met with negative results. It has been proved to demonstration that any system of manuring which produces rapid rank growth, inevitably causes a falling off in the quality of the teas produced. Excessive manuring, or the use of any mixture containing an unduly large proportion of nitrogen, leads to this result. Hitherto fine flavoury teas have been produced only when there is comparatively slow growth. But, on the other hand, slow growth alone does not necessarily ensure this. A weak bush does not invariably produce flavoury tea.

The fact that all manures are more or less evanescent has been emphasized by the experience of the Scientific Department of the Indian Tea Association, which has proved "the extreme value of very small quantities of manure to tea." This means that in order to obtain the full value of the manure applied, the same fields require to be manured year by year, with small quantities, instead of the large quantities hitherto applied in some instances, and which were supposed to be sufficient to last for several years; also that, wherever possible, the yearly dole should be divided into several applications.

CHAPTER X.

GREEN MANURING.

GREEN manuring deserves very special consideration; because it is much cheaper than artificial or chemical manures, it takes less labour for a given result, and it is more permanent in its effects. It is slower in its action than a complete chemical manure; but it is safer, in that it does not provide an artificial stimulus, which tends in some instances to soil deterioration.

It is not many years since green manuring was taken to mean only the ploughing in or hoeing of green stuff into the ground, with a view to fertilizing the soil for a crop to follow. Now, however, the expression has a wider signification, and is taken to mean also the planting of shrubs and trees, to act as perennial fertilizers amongst the particular crop which is cultivated. It is now very generally known by agriculturists that all leguminous plants, trees, and shrubs, *viz.*, those which carry their seeds in pods, have the faculty of fostering upon their

Bacteria.

roots certain bacteria, which by their activities absorb free nitrogen from the surrounding atmosphere, and transform it into a fixed condition, in which form it is readily available for the support of plant life. It has been demonstrated that the special usefulness of certain crops for green manuring and the fertilizing properties of leguminous plants and trees, are directly traceable to the presence of these bacteria upon their roots. This is a phase of the subject of green manuring which has hardly received more than passing attention from many of those who are directly interested in tea planting. Just how the activities of these bacteria can be stimulated and encouraged, and

the relative readiness with which they may be expected to seize upon the various leguminous plants grown upon the different tea soils, must, of necessity, be a study of great importance to such planters as are anxious to adopt the best methods, and to reap the best results from their daily labours, or from their investments in tea properties. Although the study of soil bacteriology is still only in its infancy, there has already been collated quite an array of established facts which must be of immense importance to all agriculturists. New facts are constantly being brought to light in this interesting study. All the latest works on every branch of scientific agriculture have much to say upon the activities of bacteria, both in regard to the formation and the fertilization of soils.

Varieties.

The form assumed by the root-nodules in which bacteria are found is different in the case of different plants, although the spherical form is the most common. Figure 13 illustrates the shape of full-grown nodules upon a young plant of *boga medeloa* (*Tephrosia candida*), although the plant was only four months old from seed. An interesting fact in connection with this is that in the early stages the nodules upon the roots of this plant are always spherical. They become elongated into egg shape as they approach maturity. Some plants carry the nodules in the form of clusters of small individuals, as in the case of *siris* (*Albizzia stipulata*), shown in Fig. 11, or in clusters of larger individuals, as on the roots of a full-grown specimen of *boga medeloa*, shown in Fig. 12 ; while in some instances as in the illustration of *moshym dal*, Fig. 14, and *dhaincha* (*Sesbania aculeata*), Fig. 15 many of the nodules tend to become anastomosed, or run into one another, especially when the plant is grown upon land which has been enriched by manure or an accumulation of organic matter.

In the selection of the particular kind of plants or trees for green manuring upon a tea estate, there are

many important factors to be considered, and it is a want of sufficient consideraton of these points which has caused some planters to arrive at the conclusion that green manuring on their particular estates is of no practical use. It is necessary to find out the particular variety which suits the particular soil. There are many kinds to choose from, as India is very well off in having a large catalogue of leguminosæ indigenous to the country. There is the important fact that the tea plant is permanently in the soil; and in growing any plant or tree between the lines of tea bushes there is to be considered the question of action and reaction of shade from both sides. There are many kinds of leguminous trees which might prove very good nitrogen fixers, but the shade of their foliage is altogether too dense for the health of the tea bushes. On the other hand, there are leguminous plants which grow splendidly upon open ground in certain climates, but they languish when sown under the partial shade of tea bushes. Climate and altitude have also a great deal to do with the success or otherwise of measures of this kind. Some plants grow well in every respect upon one portion of an estate, while upon another portion they completely fail. The reason probably is in a difference of tilth in the soil. A very stiff soil is generally unsuitable for an annual crop of leguminous plants, unless treated with a dressing of something like farm-yard manure or castor meal.

In the case of trees and shrubs, the nodules mature within a year, at most, and then decay, after having yielded up their valuable stores of nitrogen for the benefit of plants growing in the soil, while new nodules become formed upon the new rootlets of each year. No nodules are found upon old roots.

Trees.

The most economical way to enlist the services of these bacteria is by planting leguminous trees rather than by growing annual crops of leguminous plants, because, as

Dr. Mann has pointed out in his "Green Manuring, etc.," "with such trees as we have used in the past, beyond the original planting and nursing of the trees, practically no cost has been involved at all."

Siris trees.

Of all the trees which have been tried for this purpose, the best is undoubtedly the *Albizzia Stipulata*, commonly known as the *Sau* or the *Siris* tree. It was first mentioned by Colonel Hannay, but was brought into prominence chiefly by the labours of Sir James Buckingham, who did such great service to the tea industry in many ways.

This tree is truly a fertilizer of the soil. The transformation generally effected in the health of tea plants by its influence within a few years is nothing short of marvellous.

An unfailing mark of the *Siris* tree is the manner in which its new growth is formed. As each leaf unfolds it presents a somewhat ruddy colour, and for a short time hangs like a tassel. These reddish tips of young leaves on a growing tree give it quite the appearance of being in flower. On close observation it is seen that at the base of each leaf stalk, there is a pair of broad stipules clinging round the stalk like a collar. (See Fig. 10.) This is what gives the tree its distinctive name "*Stipulata,*" and is peculiar to this variety of *Albizzia*. As the leaves become mature and turn dark green, the stipules are cast off, and the tree becomes hardly distinguishable from many others which carry feathery leaves. In the off season, perhaps the only distinguishing feature is its dark bark, with deep horizontal folds; but in an exposed situation the bark is often covered with a grey lichen, and if the site is rather dry, the horizontal indentations are not very deeply marked. Gamble says, that the bark exfoliates in small scales; but this seems to be due to an insect-pest and is not always present.

Stipules.

Fig. 10.—Leaves and Fruit of Siris Tree
(*Albizzia stipulata*).

If there are any *Siris* trees growing in the neighbourhood of a tea plantation, it is remarkable how many young ones become self-sown amongst the tea. The seed pods are exceedingly light when dry, and frequently remain on the tree till March, when the strong winds at that season whirl them off and carry them sometimes for miles before strewing them on the ground. Those which become self-sown are found usually in hollow moist places. It is difficult to grow the tree upon dry poor ridges, and very difficult to grow it upon red stiff clay; but it can be done, and the result is worth the extra trouble involved in planting.

The point to be particularly noted in regard to the tree is that after it has become established in the ground, its roots sustain a new crop of nodules every year, ensuring a regular addition to the fertility of the soil, without the recurrent expense of planting, which is necessary with annual crops.

Development of nodules.

It is a very interesting question as to how the growth and development of the bacterial nodules takes place on the roots of all leguminous plants; thus giving these plants their peculiar value for soil fertilization. How much is due to the directly constructive action of the bacteria, and how much to the plant growth, which under the peculiar irritative influence of the bacteria is constrained to build up the wart-like growths which form a home for its guests. In connection with this question it may be noted that each variety of leguminous plant, or tree, has upon its roots nodules of more or less different shapes and sizes, a fact which at one time led to the supposition that the bacteria themselves were of different tribes; but this idea seems now to be exploded. On some plants the nodules are more readily developed than on others. The actual size of the individual nodules does not seem to be any

Size and number.

indication of the special value of that particular plant; the *number* of nodules seems to be of more importance than their size. In the best varieties they tend to form into clusters. On the roots of the Siris tree, these clusters sometimes measure over two inches in diameter, and so closely set are they in some places as to be nearly continuous for a little distance. (See Fig. 11.)

Soil inoculation.

A good deal has been heard of late regarding soil inoculation. It has been found that if a small quantity of soil is taken from land which has harboured bacteria of this class, cultures can be obtained by means of which a large area of land can be prepared for the successful development of nodules upon the roots of leguminous plants to be sown upon the land for the first time. In India, soil inoculation is generally found to be quite unnecessary, as the natural forests of this country are particularly rich in leguminous plants of all kinds, and in consequence there are nearly always sufficient bacteria in the soil ready to develop and multiply immediately leguminous plants are introduced.

Shade.

The principal objection to the Siris tree is that in certain circumstances the shade caused by its foliage is undesirable, and that this tends to the production of rather inferior tea. This objection can be almost entirely overcome by pollarding, or at least partially lopping the light branches at the season when shade becomes undesirable. This is probably advisable in any case, as the loppings form a very valuable manure, either for burying or for a mulch upon the surface of the ground. For very moist situations, or for rich soil with a good rainfall, there is no need to plant leguminous trees of any kind. The chief value of the Siris tree is seen when planted in lands which are naturally poor, or which are exposed to long seasons of drought.

Fig. 11.—Bacterial Nodules on Roots of Siris Tree.

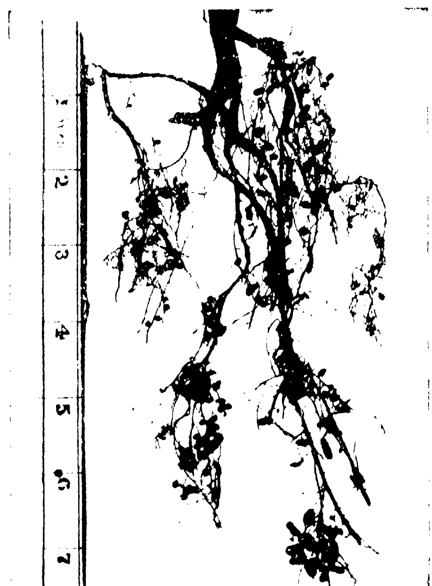


Fig. 12.—Bacterial Nodules on Roots of *Boga Medeloa*.

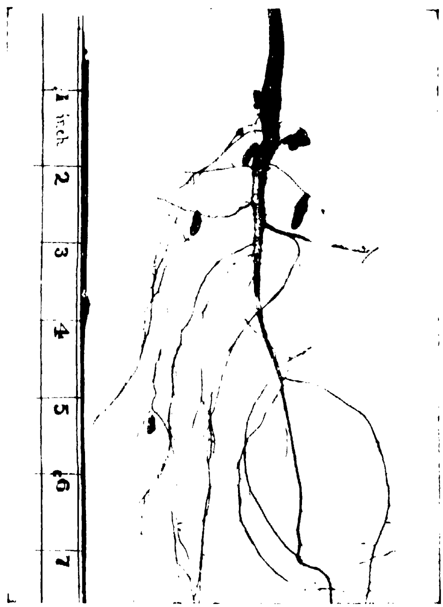


Fig. 13.—Young Plant of *Boga Medeloa.*

There are many varieties of Siris besides the *A. Stipulata*, and in situations where the climate does not favour the latter, one of the other kinds indigenous to the province may be found better. The *A. Procera* or *Safed Siris* is in some cases preferred, particularly because it is almost evergreen. This characteristic makes the several varieties of *Dalbergia* very suitable for planting as windbelts, and on estates which are especially liable to damage by hail. The dense evergreen foliage which they carry is calculated to prove an effective barrier to the passage of hailstorms.

Windbelts.

Halfway between trees and annual crops we have, indigenous to India, a large variety of leguminous shrubs, more or less suited for interplanting on tea estates. The best of these, so far discovered, is the *Tephrosia Candida*, commonly known as the *Boga Medeloa* and in the Darjeeling hills as the *Bodlelara*. It is a particularly hardy plant, and suits almost any climate, from the plains up to a considerable altitude. The chief practical advantage, in growing this shrub, is that it is suited to very poor dry soils where it is almost impossible to get the Siris to grow at all. It grows rapidly and luxuriantly, yielding benefit almost immediately. The nodules on the roots are formed at an early stage. The foliage is very handsome, and can be frequently lopped to a partial extent for mulching or manure.

Shrubs: Boga Medeloa.

The *Boga Medeloa* is a beautiful shrub to grow along roadsides for ornament, and when in flower in the autumn, presents a perfectly gorgeous sight. It has a profusion of white flowers, similar to the bloom of the ordinary pea.

An important fact also is that the bacteria are attracted to this plant most readily as the nodules begin forming upon the roots by the time that the plant is but six inches high. The usual custom is to sow the seed

at the time of the early rains, in every second line between the rows of tea, a few seeds being sown in a cluster in the centre of the space between each four bushes; then covered lightly with soil, and protected by a tripod of short stakes. A better plan is to sow in a drill right along the line, about three inches apart and thin out as the plants get up and prove to be too close, until they are about four feet, or eight feet apart, in the alternate lines. Five seers of seed may be allowed per acre. The plants must be kept lopped at intervals, so as to avoid giving too much shade to the tea bushes. This can be done three times a year, and the green stuff lopped off

Loppings.

is about 90 to 100 maunds per acre at each lopping, when the plants are growing at a distance of eight by four feet. This proves a very valuable mulch, the organic matter alone representing an important contribution to the soil, irrespective of its richness in nitrogen, and the store of nitrogen added under ground.

It is customary to allow the *Boga Medeloa* to grow for about three years, and then uproot it, and trench all into the ground at the time of deep digging.

Hail.

The growing of this plant is strongly recommended for estates which are subject to hail-storms, in which case a bushy growth is encouraged until the season for hail has passed over, after which lopping can be done with advantage.

Dadap.

The planters of Ceylon have for some years made use of a variety of *Erythrina* for green manuring. The practice was adopted from Java, where *Erythrina* has been grown for many years. The variety favoured in Ceylon is the *E. Lithosperma*, locally known as the *Dadap*, and is thornless. Although naturally a tree reaching enormous dimensions, it is treated as a shrub, and is kept down by frequent loppings. The method is to plant large cuttings, about

five feet long, which take root readily. As soon as the cuttings have become established and made good growth, they are subjected to lopping every month, and the green stuff thus cut off is usually left upon the ground as a mulch. Mr. Herbert Wright has pointed out that on an estate where the *Erythrina* was planted eight by four feet, the loppings amounted in five months to 4,020 lbs., and in two years to no less than 200,000 lbs. of green manure per acre. He says that the old plants must be grubbed up after two years and plants started again from new cuttings.

Fallidha.

The variety common in India is the *E. Indica*, known variously as the *Madar* or *Fallidha*; but it is too thorny for the purpose of green manuring. There is another variety in the jungles of Darjeeling, named *E. Arborescens* or *Rodinga*, which is only slightly prickly; but the experiments with it have not been very satisfactory. The growth of green stuff from it is trifling, compared with the phenomenal results obtained from the *Dadap* in Ceylon. The leaves are very large, causing too much shade, and when naturally cast off, many of them lie upon the tops of the bushes, covering the flushing shoots of tea, and become a perfect nuisance. A new shrub, named the *Leucœna Glauca*, has lately been introduced from Java by Dr. Hope. This may prove a very useful plant, as it is quick-growing and deep-rooted. Its capabilities have not yet been tested sufficiently to indicate what climate and soil may best suit it in India. Although a native of a very hot climate, it has already been grown in the Darjeeling district with some prospect of success.

Annuals.

Green manuring with annual crops is now largely adopted in all the tea districts. The leguminous plants and grasses, commonly known in Europe, have been tried; but the climate of India has proved quite unsuitable. This can certainly be said of clovers, sanfoin, and lupin; while

in some places ground-nuts have also been found unsatisfactory. There are, however, many indigenous plants which fulfil all the necessary requirements. Of these, the *Mati Kalai*, or *Kalai dal* (*Phaseolus Aconitifolius*), is the most favoured for growing amongst tea. There are ten or twelve allied kinds of dal and soya beans which have been tried; some have larger seeds and larger leaves than others; some more creeping in habit, while others are perfectly erect. Some of these latter may yet be found preferable to the ordinary *Mati Kalai*.

Mati Kalai.

In growing annual crops for the purpose indicated, there is to be considered the annual expense for seed, and the labour involved in planting a crop which benefits the soil only for two years at most; but the experiments carried out by the Scientific Department of the Indian Tea Association have proved that under favourable conditions the benefit to be derived is very considerable. Dr. Mann reckons that in Assam "under average conditions, and with an ordinary good growth, it will give an increase of about three-quarters of a maund of tea per acre."

Benefit.

One very unsatisfactory feature in connection with the use of dal of any kind is that it cannot be got to grow upon poor soils without the addition of manure. These are the very lands which most require treatment, and there are many such estates where manure is very difficult, if not impossible, to obtain. If manure is available, however, a very slight dressing is sufficient to give the dal a start, and then the value of the manure is greatly multiplied by the action of the dal. On poor sandy soils, about one ton of cattle manure is considered sufficient to give the dal a start; but for exhausted soils two tons per acre require to be given. Where no cattle manure is available, five maunds of oil-cake per acre is recommended instead.

Manure for poor soils.

On stiff red soils it is difficult to get any kind of dal to grow. Here, again, the necessity for manure is indicated, or a top-dressing of jungle soil, in order to improve the tilth, in preparation for the soft roots of the dal.

In manuring for this crop, it is important to avoid using an excessive quantity, in which case it is believed to hinder to some extent the development of the nitrogen-fixing bacteria, growth being under such circumstances too rank and rapid.

Some planters have been greatly disappointed with the results of their experiments in sowing *Mati Kalai*. Perhaps in most cases this has been due to the fact that wherever the bushes are so large as to practically cover

Shade.

the ground, the shade which is thus produced renders it quite impossible to grow a good crop of any kind of dal. In such circumstances the seed germinates well; but whenever the plants get to be three inches high, they begin to languish, and only a small proportion of them are able ultimately to struggle up into light and air; the result being a practical failure, which is due entirely to the shade of the tea bushes. But, on the other hand, if the bushes are heavily pruned, and a crop of *Mati Kalai* sown upon that same land, there is a very different story to tell; the dal will grow up with great luxuriance, rapidly enveloping tea and everything else, if allowed to do so. The moral herein contained is that when a block of tea has to be

Heavy pruning.

heavily pruned, an opportunity is afforded for growing a crop of dal to perfection. If the tea is to benefit, however, the dal must not be allowed to twine round and strangle the young shoots, or to overshadow the growth in such a way as to weaken the bushes.

Some planters have the impression that the growing

Quality.

of *Mati Kalai* on the land causes a distinct improvement in the quality of the tea from the plots treated. This suggestion is worthy

of the most careful investigation, although the probabilities point in the opposite direction. It has already been established that where dal can be got to grow, it ensures an increase of quantity.

Soya Bean.

For an annual crop some people prefer the soya bean, commonly called *bhot mas*, for sowing amongst the tea; but it is doubtful whether the most suitable variety has yet come into general use. The principal objection to most varieties is their twining habit, and the consequent damage which they do to many of the tender new shoots on tea which has been heavily pruned. A plant which has proved particularly useful for almost any elevation is the *moshym dal* (Fig. 14). It is hardy, and stands the shade of the bushes fairly well, and the foliage of it is not so troublesome to the tea branches as most of the other sorts. The *Barmelli bhot mas* is partially erect growing, and a very suitable kind for green manuring. The *Nepauli bhot mas* grows quite erect (Figs. 16 and 1), and is suitable for high elevations, but does not grow well upon very poor soil. The nodules which are shown upon the roots of this plant in the illustration are typical of the several varieties of soya bean and dal. *Dhaincha* (*Sesbania aculeata*) shown in Fig. 15 is a plant which has proved very useful in some estates, and deserves to have a larger vogue. It grows erect, to a height of eight or ten feet; but is generally lopped at intervals, in order to keep it from giving too much shade to the tea. It is not an edible plant. *Arhar dal* (*Cajanus indicus*) is an erect growing variety of dal, and at one time a good deal was expected from it; but in practice it has not proved so satisfactory as had been expected.

In the selection and cultivation of annual crops for the purpose of green manuring there are one or two facts of great practical importance. There is generally a direct ratio between the amount of growth developed

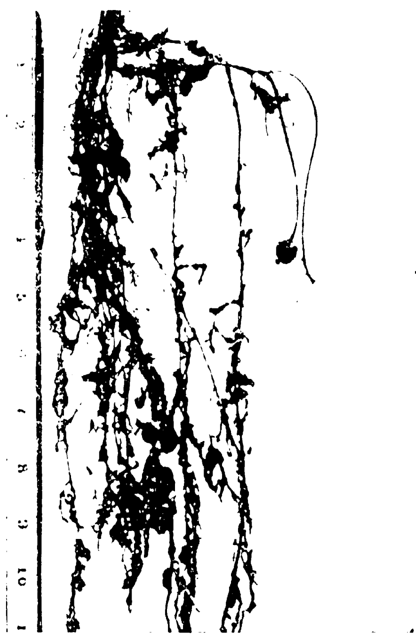


Fig. 14—Nodules on Roots of *Moshym Dal*.

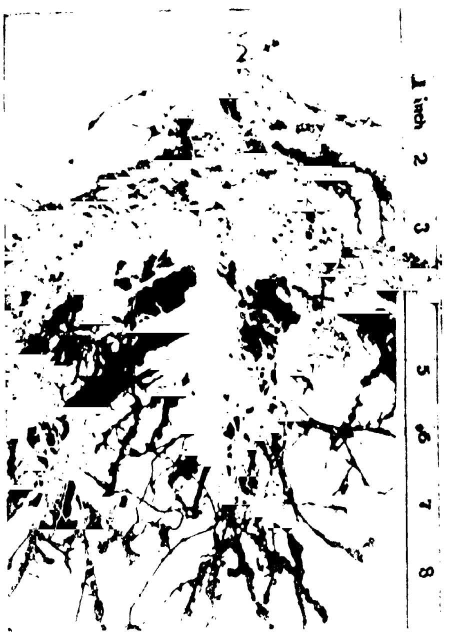


Fig. 15.—Nodules on Roots of *Dhaincha*.

Fig. 16.—Nepauli Bhot Mas. or Soya Bean.

above ground and the volume of nodules upon the roots.

Sowing.

A crop which is sown early, provided that the conditions are favourable for growth, produces a much more abundant growth of green stuff than the same crop sown at a comparatively late season. Native farmers, who grow such crops for the resulting grain, sow rather late in the season, in July or August, as they know that the early sowings give too much green stuff and very little grain. The best time to sow for green manuring is whenever good spring rain has fallen; only that it is to be remembered that the crop will not grow at all until the ground is wet to a depth of at least six inches. In some cases it is possible to sow in April, in others where the climate is naturally dry it is not possible to sow successfully till the middle of May or June.

Seed per acre.

The seed is sown in the rows between the tea bushes, after the soil has been dug over, and is lightly covered over with soil after sowing. In some cases the seed is broadcasted, but with the bigger and stronger varieties it is advisable to sow in a drill down the centre of the space. About 40 lbs. of seed to an acre is ample. In the case of the smaller classes of seeds there will be more plants, while the larger seeds give larger plants; but the weight per acre works out about the same. Sowing may be made in every line, and the coolies be allowed to tread freely upon the growing plants when plucking the tea leaves, as the light treading with bare feet does very little harm to the young dal. In the case of twining or trailing varieties a little labour has to be spent upon training the young plants as soon as they begin to climb over the tea bushes. The plants are carefully pulled off and laid along the ground. Children or old women do this quite quickly, and the cost is not great. When lying along the ground many of the stems are induced to send out adventitious roots; and the writer has frequently seen stems of *moshym dal* fixed to the

ground in this way for a distance of as much as two and three feet, with clusters of roots at intervals of two or three inches the whole way along the stem, and six inches deep in the ground; each cluster of roots having a complete set of bacterial nodules attached.

Dhaincha.

Another plant which has given great promise of usefulness is the *Dhaincha* (*Sesbania aculeata*), concerning which Dr. Mann says: "We are inclined to think that this crop offers greater possibilities for green manuring purposes than any we have at present, even including Mati Kalai." The seed of this plant is not easily obtained, because it is not grown anywhere as a food-crop, and only in some parts of Bengal for subsidiary purposes. The fact that in two months *Dhaincha* can grow to a height of six to ten feet shows how rapidly it develops; and if used at all for planting amongst tea, it must be hoed in at a very early stage; otherwise it must overshadow the tea bushes, and in this way do more harm than good. The use of this plant is in the experimental stage, and it may yet prove to be of great value. It is recommended for sowing upon stiff soils.

In connection with green manuring generally, it is important to note that there is a certain stage when green stuff has attained its greatest value for manurial purposes. This is just at the time of flowering. At this stage the plant has stored up in its leaves and stalk a maximum of nourishment, to be used for the formation of fruit or seed. When the seed has become fully developed, however, the leaves have parted with the constituents which were most valuable, and are no longer so useful for manuring. This is true of trees as well as of plants. An illustration of this has been noted when lopping the branches of Siris trees amongst tea; if this is done in June, about the time of flowering, it is found that after a few days, the stench given off from the rotting leaves is

almost overpowering; whereas in the case of loppings in September or later, there is very little odour at all. In the first case the rotting leaves were giving off a vast amount of ammonia and other gases into the atmosphere, proving that they carried abundance of manurial material.

The length of time which should elapse before the crop is cut or dug into the ground varies in different circumstances; but is usually about six to eight weeks, and about two weeks longer on the hills. A good rule is that the crop has reached its maximum of usefulness when the plants begin to flower. On level country it is then hoed into the land; but on steep hill-sides, where it would be nothing short of madness to dig during the rains, the crop is merely sickled and left upon the ground as a mulch, till the time has arrived for the autumn deep cultivation. No planter need be afraid of losing much by sickling instead of digging in such circumstances. A little of the nitrogen will certainly go off into the atmosphere from the green stuff during the process of drying; but the principal benefit is already in the soil, as has been proved by scientific analysis, and by practical experiment.

Maturity.

It is a well-known fact that the stems and leaves of a leguminous plant contain a larger proportion of nitrogen in their substance than that of other plants, but a fact which is liable to be overlooked is that during the growth of such plants a very large quantity of nitrogen is added directly to the soil. The scientific experiments at Rothamsted have shown that after a crop of clover the soil was found on analysis to contain per acre 375 lbs. more nitrogen than the corresponding plot of ground which had been sown with barley. It is worthy of note that the crop of clover had been cut and carried off the land.

Fertilization of soil.

In another set of experiments it was found that the benefit to the soil from a leguminous crop persisted for

at least three succeeding years; during which crops of wheat, roots, and barley were sown upon a plot which had previously grown clover, and a check plot which had been a year fallow; the resulting difference in favour of the clover plot was 22%, 36%, and 89% for the three years respectively.*

It has been found on analysis that the bacterial nodules themselves do not contain a large quantity of nitrogen; but the fact that the soil gets a very large increase, as a result of their activities, may be sufficient for the practical planter.

Increase of crop.

Dr. Mann has stated that green manuring may be expected to yield an increase of about 60 lbs. of tea per acre. This is quite a moderate estimate. By actual experiment the writer has noted an increase of fully 70 lbs. of tea per acre on a hill estate, at an elevation of 4,000 feet, and the increase on plains estates must be considerably more.

Failure.

The failure, or partial failure, of some tea estates to reap definite benefit from green manuring may be due to several causes. The kind of crop selected may not have been suitable for the particular climate or soil, and some other variety might be found more successful. The cover of tea bushes may have been too dense for any crop to grow through. In such cases the only time when green manuring can be successful is immediately after heavy pruning. A partial failure is sometimes caused by quite a sordid fact. The dal which is used for seed is a palatable and nourishing diet for the cooly, and if supervision is not very keen, the cooly carries away in some recess of his clothing a considerable portion of the grain which he is supposed to have sown upon the ground, with quite a natural result. In order to checkmate conduct like

* Hall's "Fertilizers and Manures," p. 33.

this it has been found effective to steep overnight the seed for each day's sowing in liquid manure. Not cow manure, as a Hindoo would never consider that any contamination, but in horse or goat manure. The liquid manure assists germination of the seed, while it ensures that the seed will be duly sown.

CHAPTER XI.

RENOVATION OF DETERIORATED AREAS.

ALTHOUGH the tea plant is remarkably hardy and tenacious of life, so much so that some people reckon that it will live for a hundred years or more, yet, if not carefully treated, it soon begins to deteriorate and to become unprofitable.

Age of deterioration.

The Scientific Officer for the Indian Tea Association recently stated that the older gardens in Assam were "manifestly deteriorating," and some well-known authorities have declared that with ordinary treatment, the tea bush begins to deteriorate about the twelfth or fifteenth year. However this may be, it is certainly a very common thing for a tea planter to be put in charge of an estate which has become very much run down, with many plots containing bushes which have got into a most unproductive state. What to do in such circumstances is naturally a very important question, and the question becomes the more complicated if the new manager's term of office is somewhat tentative and dependent upon immediate results. In any case it would be a mistake to adopt what might be described as heroic measures, without first considering very carefully the circumstances of the case, and it is generally advisable to work the estate for one season on moderate lines, until the actual condition and capabilities of the different plots can be fully understood.

Difficulty.

The renovation of poor tea is always difficult and tedious, and if it is to be successful, the proprietors of the estate must be prepared for expenditure and loss in the first instance before solid improvement can be attained.

If we have poor soil and a bad class of plants, with long years of bad treatment, the case is well-nigh hopeless. If the property contains any reserve of good land, the wisest course will be to plant this out with good seed on modern methods and just abandon the old fields entirely, at least for a time after sowing freely with the seeds of some leguminous tree, such as the *Albizzia* or *Siris*. This would in a few years become a forest, bearing useful fuel, the new trees also rendering the soil somewhat more fertile and gradually preparing it for re-opening if this be thought desirable.

Abandoning tea.

On some estates there are plots of tea which never should have been planted; they can never be anything but unprofitable, and the only sensible course is to abandon them, whether the area can be otherwise made up or not. The responsibility of abandoning tea is not light, but as soon as the matter has had due consideration and the proprietors are satisfied that there is no hope of *profits* from such fields, they must be abandoned without compunction. The longer the delay in coming to this conclusion, the greater the loss.

Burning.

Some people have recommended burning a plot of tea, and then leaving fallow for a year in order to renovate it. It is stated that the fire will destroy blights and prepare the bushes for a new lease of life. This may be a good plan, but requires the test of experience. It is not likely to succeed unless the tea can be kept free of weeds during the rains; if this has to be done, it may also be as well to take a little leaf from the stronger bushes which may be running away.

Heavy pruning.

Heavy pruning is thought by some people to be a direct and immediate cure for anything; but it is not to be undertaken without extreme caution and not without previous special

treatment, in the case of very weak bushes, which cannot stand such a shock.

Manuring and top-dressing.

Manuring and top-dressing are the only means from which immediate improvement can be expected; the latter by preference, as already shown in the chapter which deals specially with this subject, and wherever possible on a large scale may be undertaken with the certainty of very satisfactory results.

Light cropping.

As a physician would prescribe for a patient in delicate health a period of rest and good nourishment, so the one necessary thing for a garden which has got into an unhealthy state is light and judicious cropping with good cultivation and generous treatment.

Leguminous fertilizers.

Where the soil is naturally poor, and neither top-dressing nor manuring possible because of expense, etc., a great deal of good may be done by green manuring with leguminous crops, or by planting leguminous trees amongst the tea. The *Leguminosæ* may be described as those trees and shrubs which carry their seeds in pods, like peas or beans.

Whatever other measures may be adopted, there cannot be the least doubt that to *crop lightly* for a time is the most effective method of renovation. It may be said with regard to most of the estates which have deteriorated, that the chief thing from which they are suffering is close plucking; sometimes aggravated by severe treatment also in other ways. The bushes are crying out for a period of rest. What they want is to have an opportunity to effect their own recuperation.

When a block has become manifestly unprofitable, the first question to be decided is whether the soil itself is of a sufficiently good class to be retained in cultivation at all. If this can be answered in the affirmative, and it is proved that the trouble lies in an exhausted condition

of the bushes, then it is possible to effect its complete renovation by working the block at some slight loss for two years. Cultivation should go on in the usual way, or even better than ever, but the bushes should be plucked very lightly, either to a measure of about three feet from the ground, or some other definite system should be adopted, which will ensure that only the stronger bushes will be cropped, while the weak ones shall be left entirely alone, except for tipping the longshoots. All tea seed should be rigorously stripped off the bushes as soon as it has set.

Remove seed.

During very busy times, when there is a very heavy flush on the estates, leaf being too abundant for the plucking staff to deal with in good time, the weak block can be left entirely unplucked, until the staff has caught up upon the flush, and there is labour available to devote to the block under special treatment. If the leaf on it has run banjy, it should be left severely alone.

During the succeeding cold season it is advisable that the whole block should be left unpruned, and get a good dusting of sulphur as a protection against red spider. During the following season the cropping should again be very light. If a measure is used, it should be made a foot higher than before. During the succeeding winter the bushes may be pruned in the usual way, when the block may be expected to enter upon a new lease of life. This may be described as a method of renovation without any external aid, but the use of manures and fertilizers will always greatly facilitate the work of renovation.

Age promotes urgency.

As tea gardens get older and the soil becomes more and more impoverished or the bushes get weak, the necessity for some renovation becomes the more urgent. The places which specially require treatment are exposed teelahs or knolls and ridges, from which a great portion of the best soil

has been washed away, and also high-lying plateau land which is liable to suffer from long droughts. On hill gardens, the portions which suffer most are the dry

Dry ridges.

ridges, especially those facing west, and all places where roots have become exposed through long years of cultivation and perhaps injudicious treatment. In such circumstances the slight

Shade.

shade afforded by the Siris tree, even apart from the fertilizing agency on the roots, is of immense benefit to tea.

This tree is in some circumstances also beneficial in

Windbelts.

forming windbelts, to protect the bushes from the influence of hot dry winds. In Ceylon, the Grevellia tree is largely used for this purpose as well as the Siris, but it has no special fertilizing agency on the soil, except that its cast-off leaves are said to form good manure as they contain a large proportion of lime.

Light shade of any kind is good for tea in distressed circumstances, provided that the trees used for the purpose do not combat with the tea for the little nourishment and moisture which may be available. That the latter is not the case with Siris is amply apparent, because in the season of greatest drought it is always found that the bushes around a Siris tree continue green and vigorous, while on the rest of the plot they are yellow and drooping.

The two objections to Siris are :—*1st*, it is thought

Objections to Siris.

that the shade afforded hinders the development of leaf in the growing season, or that the leaf produced is of inferior quality; *2nd*, that the roots make a perfect mat along the surface of the ground and hinder cultivation.

With regard to the first objection, it probably has some weight with reference to Siris planted in situations which are naturally moist and do not require the Siris at all. In these circumstances it tends to the production of rank growth of leaf which becomes developed rapidly

without the juice getting sufficiently elaborated by sun and air, etc., to become good tea. On weak or dry plots this is not so ; the presence of Siris brings about a return to the natural conditions of healthy growth, and there is a large increase of crop, which has been proved to be of fully as good quality as the leaf gathered from perfectly open ground. Even in fairly moist situations, the Siris can be grown with advantage, if the trees are moderately pollarded at the season when their shade becomes hurtful or objectionable.

The second objection has force only when the trees are allowed to grow too old. If they are cut down when they reach about four feet girth, the rotting roots add to the fertility of the soil, and the good influence of the tree lasts for several years after it has been removed.

Post-mortem influence.

To plant Siris trees upon very dry open ground is not an easy matter. In its natural state, it prefers moist or shady places, and luxuriates in rich light soil. The work can be done, however, if set about in the right way and if proper care is exercised.

Difficulty of planting.

There are several kinds of Siris trees, all varieties of the *Albizzia*. The best for our purpose is the *Kala Siris* or *Albizzia stipulata*. It flowers in June, and the seed ripens about the end of the year. After the pods ripen, they dry up and cling to the tree in brick-red clusters, long after it has shed its leaves for the winter. This tree grows freely on the plains, and on the hills up to 5,000 feet.

Flowers and seed.

The seed may be sown in nurseries or at stake ; if the latter, it must be kept until the ground has become thoroughly wet, which might not be until May or June. It keeps well in charcoal-dust, with a little flower of sulphur. To facilitate germination, the seed may be steeped in hot water

Sowing.

(130°F.) for twelve hours previous to sowing; if kept hot all that time, it will then germinate within a few days, provided it is sound. The seed is merely sprinkled upon the beds and then some light soil sprinkled over it.

Steeping seed.

If new land for nurseries is not available or convenient, a good plan is to make small nurseries within the tea at suitable points all over the estate. The space between two lines of tea in a somewhat moist place is selected, the soil pulverized, smoothed, and made into a seed bed; then the seed is sown in a manner similar to carrot seed in a vegetable garden; the bed is then staked or fenced in such a way as to prevent coolies treading upon it.

Nurseries.

The best time for sowing is whenever the ground has become thoroughly wet by spring rain, in which case the seed germinates readily. If sown upon dry ground, it is liable to be destroyed by insects before germination can take place.

When sown at stake, the seed should be placed in the line of tea, where it will not be trodden upon, and in hill-gardens on the face of terraces, the part which is not cultivated, where it will stand less risk of being hoed or dug up during cultivation. It should be protected by three or four stakes about 18 inches long, driven deeply into the ground, so that only six inches remain above the surface. If the stakes are long, the coolies will steal them for firewood.

Seed at stake.

It is important to note that the Siris is deciduous, and during winter the young plant is very liable to be destroyed, as it is leafless, and looks like a mere dead twig.

Deciduous.

The most certain method of planting is by the cold weather system, with large unbroken balls of earth. If it is intended to do this, the seedlings should be pricked out of the nursery

Cold weather planting.

beds shortly after germination and transferred to new beds, planted eight inches apart and well watered. These beds should be of fairly stiff soil, and as near as possible to the situation where the trees are to be planted.

All very dry ridges should be planted in this fashion; the work can be done in December or January; the one important point to be seen to is that each seedling is taken up in a large solid ball of earth, absolutely unbroken and undamaged, and in this condition carefully planted in its new site.

Rains transplanting.

Small seedlings transplanted during the rains do not readily succeed. If this kind of planting is to be done, it is better to use plants of three to five feet high, which represent the age at which they can best stand the shock. Plants of eight or nine feet succeed very well if carefully done; the top should be cut well down and the roots must be shortened a little, but not excessively, and a small amount of soil must be kept clinging to the rootlets while being carried to their new site. Sometimes such large plants die back after transplanting, but after a time they nearly always sprout away again vigorously from the collar. Successful transplanting is most readily assured if the plants are cut down to half their height, or even down to a stump of nine or twelve inches, but the objection to this is that the new growth tends to form a spreading bush instead of an upstanding tree.

Large plants.

Distance apart.

Seedlings may be put in about ten feet apart, or even closer if they are plentiful. After growing up, and as soon as they begin to form a canopy, they should be gradually thinned out until about 50 feet. At this distance they may be allowed to grow till they reach a girth of three or four feet when they are to be cut down and others take their place. When once a plot of tea has been planted with Siris, there is no difficulty about renewals, because abundance of

young seedlings become self-sown, and it is merely a matter of selection.

After becoming fairly established, the Siris makes very rapid growth, and under favourable circumstances will attain to the size above referred to in ten or twelve years; it is then very useful timber for fuel, etc., and if planted extensively on an estate, will go a long way towards supplying the fuel for factory use. There is a thick ring of soft white sapwood, but the core is dark red-coloured hard timber, which is really useful. When allowed to grow to about 30 years old and ten feet girth, the wood is hard and tough, and is useful for many purposes. It makes excellent box boards, about the same weight as toon.

Siris as fuel.

The one drawback to this tree is that it is very liable to be infested by a beetle borer which burrows into the trunk in such numbers as to render the timber useless for sawing into boards, and sometimes causes the trunk to become so weak that it is readily broken down by a gale of wind. When this happens the stump almost invariably sprouts away again and forms a new tree.

In all measures for renovation of deteriorated areas, the suggestions made in the chapter on manuring are specially applicable. Green manuring by means of leguminous trees or shrubs of any kind is certain to be of the greatest value, as well as the growing of leguminous crops amongst the tea. Deep trenching and green manuring with jungle stuff is perhaps the most efficient, although also the most expensive method.

Replanting.

On estates where the soil is good, but the bushes of very inferior class, the true method of renovation is to uproot and replant the whole, block by block, as labour for the purpose may be available, especially if the tea is fifty or more years old. This is a work which is not to be lightly undertaken however, as it is exceedingly difficult to replant successfully on exhausted land. It is also expensive.

To ensure success in the replanting it may be desirable to keep the cleared land fallow for one year, or to grow upon it a leguminous crop, then give the land another deep digging before planting.

The work may be done very successfully in the cold weather by ball planting. If the planting has to be done during the rains it is necessary to use plants which are at least three years old. Only strong healthy plants give any hope of success.

Manure.

For the first three years after replanting, the young plants require to have dressings of manure. This may be a complete chemical manure, with perhaps a little castor meal. A convenient chemical manure for this purpose consists of nitrate of potash and basic slag, in equal proportions; one ounce of the mixture to be sprinkled round each plant in spring, and once again in midsummer. The application in midsummer might in some cases have the addition of one-third of an ounce of sulphate of ammonia. If castor meal is given in addition, it might be broadcasted, at the rate of 400 lbs. per acre.

The object in giving manure to young plants in such circumstances is to assist them to develop growth vigorously in land which has been impoverished by sustaining tea bushes for many years. During the first two or three years the soil in the spaces between the new bushes will be enjoying a period of rest, and by the time that the new plants begin to extend their roots throughout these vacant spaces a source of new plant food will become available in this renovated soil, and the special manuring can then cease.

Boga medeloa.

At the time of replanting it is advisable to sow Boga Medeloa between alternate lines of tea.

CHAPTER XII.

TEA BLIGHTS.

THE subject of pests and blights requires special study and cannot be dealt with in sufficient detail in a work like this. All that can be attempted here is a sketch of the general principles upon which the enemies of the tea plant may be most successfully met, and a few details regarding some of the most common and serious of those at present known. Any reader wishing to study this subject more fully is referred to the book on "The Pests and Blights of the Tea Plant," by Sir George Watt and Dr. Mann, which is considered a standard work; also to an excellently descriptive little book on "Tea Insects," by Mr. E. C. Cotes, which has some good illustrations; and also various publications by the Scientific Department of the Indian Tea Association. The blights of the tea plant are legion. They may be described as of three classes: (1) The attacks of minute animals or insects. (2) Vegetable parasites. (3) The violence of the elements, such as hailstorms, etc. It has become customary to class insect enemies as *pests*, and vegetable parasites as *blights*.

Classes of blights.

Although by far the largest number of our insect enemies have hitherto proved comparatively harmless, it is neither wise nor safe to assume that such enemies may be absolutely neglected. The proper attitude for the planter is to be on the alert and to make use of every possible protection and safeguard.

Blights follow agriculture.

The experience is similar in every department of agriculture, that whenever any kind of cultivation is conducted on a large

scale, the danger of injury or destruction from any particular blight becomes very largely increased, because, when a destructive insect lights upon an enormous field, containing an uninterrupted supply of the kind of food which exactly suits its constitution and general construction, the natural result is a rapid increase in its numbers and strength; this going on in an ever-increasing ratio until complete devastation and destruction of the crop supervenes; unless, meanwhile, some sort of check is placed upon it, or means devised whereby the invader can be destroyed or driven off.

Liability of tea to blights.

The tea plant is more liable to suffer from blights than any kind of annual crop can be, because it is permanently in the ground, and it is more liable than most fruit trees, because it is an evergreen, and gives ample opportunity for insects or fungi to deposit their eggs and spores wherever suitable, and so to ensure an ever-recurring and continually increasing brood or crop of the enemy upon the very field of attack.

Scientific experts.

Neglect of such developments has in the past brought ruin to many industries. The importance of the matter has led the Governments of some countries to establish special departments and to employ a staff of scientists, whose only duties are to study the nature of agricultural blights and to render every possible assistance to the cultivator in order to effect their extermination. Some of our own colonies are not behind in this matter; Australia, for instance, has its separate specialists for insect and for fungus blights, whose assistance can be had free of cost by any farmer requiring special advice.

Government assistance.

Previous to 1902, very little of this sort was done in India, and what little was done by Government for the tea industry had been spasmodic and superficial. In 1901, however, a

Scientific Officer was engaged by the Indian Tea Association, assisted by a grant from Government; planters will no doubt give him and his assistants every facility and assistance in their investigations, and also make full use of the results of their researches as time goes on. This appointment should certainly be permanent, fully supported by Government, as individual planters cannot possibly give the time and study necessary to cope with the subject sufficiently, and even if any one could do so, the results of his work would be of little use to the industry generally.

The Scientific Department of the Indian Tea Association has lately been somewhat developed and extended, and several experts are now employed; but very little has yet been done by way of experiment and demonstration. The Department has one experimental station; but the experimental feature of it might with advantage be greatly expanded. It is the opinion of many planters that there should be an experimental station in each of the tea districts for practical investigation of the various problems affecting the industry, and for demonstrating the best methods of culture and manufacture. The Department has done good work, but there is still a vast field awaiting study and investigation.

The use of insecticides is not to be ignored; in any case, however, they should be first used experimentally, upon a small area, before being adopted upon any large scale; very great care is to be exercised in such experiments and in judging of their results, because it has often happened that a particular insecticide got the credit of effecting a cure which was in reality due to a different cause entirely. Sometimes an insecticide has been used on a large scale with the utmost confidence because it had been known to cure something else, the result proving wholly unsatisfactory. A poison for one kind of insect may be absolutely harmless to another.

Inaccurate experiments.

There are many kinds of insecticides which might prove useful for destroying certain blights, but are impossible of application to the tea-bush, because of their being mixed with deadly poisons, some of which might inadvertently be gathered with the leaves for making into tea.

Fire and Sword.

The planter cannot be too earnestly cautioned against the fire and sword policy advocated by some people as a cure for almost everything. Cutting down and burning has been resorted to much too readily in the past. There are certainly times when extreme measures have to be undertaken, but it should be only with extreme caution, and after every moderate measure has failed.

Sympathy.

When plants are suffering from any kind of blight, they need sympathy and help. Anything which will tend to hearten and strengthen them will go a long way towards throwing off the enemy, or at least towards a complete recovery after the attack is over. On the other hand, the probability is that severe treatment will only further weaken the bush and render it a more easy prey.

Close plucking.

It is not an uncommon thing for a planter, when blight appears, to give orders to pluck as closely as possible, leaving not a vestige of new growth, when the probability is that the extra labour would be a hundred times better employed in cultivating the soil and stimulating the bushes.

In the same way, cutting down and burning has sometimes been adopted without the least benefit ; the new shoots are immediately attacked by insects from the neighbourhood as before, and the plants being in a weaker state, are liable to suffer more than ever.

Seasons for blights.

Most blights have their season and disappear in a natural way when their term is over ; the eggs of the insects are, however left somewhere near, most probably on the bush itself.

nside the bark or stems, or on the surface of the older eaves, ready to be developed when the suitable season comes round again.

Natural checks.

Were it not for the natural checks to which most blights are subject, the tea plant would soon be devoured from off the face of the earth. A change of weather may make the conditions of life impossible for any particular insect. A change of season has in some cases the same effect, so that we know exactly when to expect the appearance of certain pests, such as red spider and also when the attack will be over; a few of these mites may indeed be seen at other times of the year, but never to any harmful extent.

Insect enemies.

Perhaps the most important check is that which is brought about by natural enemies. As has been already pointed out, all insect pests spread and multiply very rapidly when conditions are favourable to their development; on the other hand, however, there are insects of a carnivorous and some of a parasitic nature which prey upon these, and when they also get a start, the career of the first may be cut short, or at least be very greatly restricted.

Curiously enough, some of these parasites deposit their eggs in the very abdomen of their victims, so that the insects themselves are thus made to foster the means of their own eventual destruction.

It is for some such reason as those mentioned above that very often the mosquito blight receives a severe check or even disappears entirely for a time, in a most astonishing and unexpected manner.

Red Spider.

One of the oldest enemies of the tea plant is the *red spider*. Many remedies for this have been tried, including every known insecticide. Some of these have a very marked effect upon the blight for a time, but none has yet been found

to work a complete and permanent cure. Planters have also tried pulling off the affected leaves, burning prunings, heavy pruning, light pruning, late pruning, thinning out, etc., all without the slightest permanent benefit. The only effect which late pruning has is that the blight appears a little later, but its results are just as serious.

Time of appearance.

The time of appearance of red spider is when the leaves of the first flush begin to mature and harden, usually about the end of April. A red tinge first appears on the leaves, and it would seem as if the eggs were within the sap itself, and that the mites make their way to the surface immediately on being hatched. Very soon the old leaves are all covered with minute red animals or insects. They can with difficulty be seen by the naked eye, running about with great energy and extracting the juice of the leaf, which, in consequence, gradually dries up and becomes brown before eventually falling off the bush. Some people fancy that heavy rain washes off the red spider. There is reason to doubt this, because at times very heavy showers of rain have fallen early in May, when the blight has been at its liveliest stage, and whenever the rain had cleared away the insects or mites seemed even more active than before. When a heavy shower of rain comes, they run to the underside of the leaves, where they are perfectly safe.

Heavy rain.

When the attack has become severe and the older leaves are all sucked dry, the mites attack the new growth of the second flush ; the weaker bushes soon give up the hopeless struggle, and for a time all growth on these is almost completely stopped.

Time of disappearance.

About the middle of June, or at the time of the advent of the monsoon rains, the red spider has come to the end of its span of life, and practically disappears, leaving its eggs in a suitable place for the development of a new progeny, when its season has again come round.

Permanent effects.

The permanent evil effects of this blight are perhaps more serious than of any other to which the tea plant has hitherto been subject on any large scale. The bushes attacked become more and more enfeebled after each attack; they gradually get into a sort of anæmic state, and the stems and twigs become white with parasitic growths.

Flowers of sulphur.

There are various preparations in use for checking or mitigating the effects of red spider. The most effective yet known is flowers of sulphur. The best time for application is shortly after pruning, and long before there is any sign of the insects' appearance. The bushes are first wetted thoroughly by means of a garden syringe, then the sulphur is dusted on from a bag of gunny or other cloth of open texture, or blown on the leaves by machine. The machine is much more effective and economical than the rough method; as it distributes the sulphur evenly upon the leaves, and ensures the best results possible from a given quantity applied. The only objection to the machine is that the material is liable to clog the bellows if there is any dampness present. The application reaches the spiders at once, because they are always found on the upper surface of the leaves.

Quantity of sulphur cost.

Two cwts. to an acre gives a very good dressing, but a thin dressing of one cwt. or even less has been known to be very effective. A mixture of some finely sifted wood-ash makes the sulphur go further and is itself a valuable manure. The total cost is about Rs. 20 per acre. If the sulphur is not immediately washed off by heavy rain, its good effects may be absolutely depended upon.

Although sulphur does not permanently banish red spider, it does real benefit to the bushes of badly affected blocks, by giving them one year's immunity from attack and consequent opportunity to recuperate.

Pink mite.—The effects of this pest are somewhat similar to those of *red spider ;* they are not so apparent or so severe, but they are fully as widespread.

As *red spider* is most severe upon low *jât* or China bushes, so *pink mite* is to be found mostly upon delicate high class varieties, especially on Assam Indigenous.

Season

The season for the appearance of this pest is the same as for red spider, *viz.*, in April or May, after the first flush has been plucked, and when the new growth begins to ripen upon the bushes. The leaves then assume a yellowish tinge, gradually changing to a dull red rusty colour, giving the impression that they have been attacked by red spider, only that no spider can be seen actually on the leaves.

Minuteness of mite.

The pink mite is so minute that it cannot be seen by the naked eye ; but with the aid of a microscope, an infected leaf is seen to be occupied by myriads of them which, as has been pointed out by Sir George Watt, eat into the fibre of the leaf and break open the stomata. This is no doubt the cause of the rusty appearance and of the gradual drying up of the leaf itself.

Severe attacks.

When the attack has been severe, the leaves in course of time become a reddish black, and eventually fall off the bush. This has no doubt given rise to the impression that the finer varieties of the tea plant are deciduous, because at a certain season of the year whole fields of tea bushes may be seen to have shed nearly all their leaves ; whereas the real reason for this is that the leaves have been so damaged and destroyed by the mite referred to, that they are no longer able to perform their natural functions, and the plant has to cast them off. This is the more remarkable, when it is observed that the leaves thus cast off are not

New leaves cast off.

old leaves of the previous year's growth, but new leaves of the first

flush which have newly ripened, and which ought to be of the greatest value to the plant, by performing the chief functions of digestion and assimilation. It will thus be seen how much damage can be done by this unseen enemy, and how important it is to devise measures against it, especially on gardens where most of the plants are of a delicate class.

As soon as the heavy rains come on and the second flush begins to grow away freely, the bushes usually begin to recover from the effects of pink mite. It is then that the badly-damaged leaves are cast off, and the brick colour of the tea changes to a healthy bright green.

Remedies.

Very little has been done in the direction of finding a remedy for this pest, because the disease is not generally recognized as such, and planters generally assume that the weak suffering condition of the bush during the hot season is but an indication of its delicate *jât*.

Effects of shade.

It has been observed that bushes growing in a moist shady situation seldom suffer from the attacks of pink mites. The same is the case with bushes growing in the shade of toon or other trees with dense foliage, and those growing around the Siris tree are but little affected by the mite. The most permanent and sure remedy, therefore, seems to be to plant Siris trees in all fields which are subject to attacks from this pest. When the full growing season is on, and the shade of the Siris is no longer required, its younger branches can be lopped off.

Sulphur.

Flowers of sulphur has the same effect upon this mite as upon red spider; it is banished entirely for the year following the application.

Mosquito.

Another serious enemy to tea is the mosquito. This at one time threatened to destroy the industry, and indeed it did bring about

the ruin of several companies in the Darjeeling Terai about the years 1888–90.

Its operations are mysterious, and its coming and going sometimes quite incomprehensible, although the time when it does greatest damage is usually after the growing season is half over.

The fact that the mosquito is a winged insect renders it somewhat difficult to deal with in its mature stage. A good deal of the life-history of this insect has already been recorded by the Scientific Department, but as yet no reliable or complete cure for it has been discovered. The female inserts its eggs in the body of the green stalks of a new flush ; they are thus completely protected until hatching takes place. When the young insect emerges, it is unable to fly, its wings not yet being sufficiently developed. At this stage, it does most damage, and it is also at this stage that insecticides may be expected to have most effect. The young mosquito feeds upon the sap contained in the green stalks and new leaves of the bush ; it inserts its proboscis and sucks the sap in the same manner that the common mosquito sucks blood from its victim. Wherever the proboscis has been inserted, a small round patch of dead tissue is the result. As the insects become more numerous, the number of these patches increases, until the young leaves all assume a blackened appearance. When conditions are favourable for the pest and the attack has become a very severe one, the overcrowded insects seize upon any young buds which manage to make an appearance, and soon the whole block of tea presents a truly blighted look, the whole of the bushes showing upon their upper surface nothing but a series of curled and blackened ends turned up to the sky, all new growth being stopped. This condition of things has sometimes obtained over quite a large area on gardens in the Terai, even as early

Winged insects.

Mosquito marks.

Severe attacks.

in the season as the end of July, the very time when growth should be most vigorous and luxuriant. In ordinary circumstances, however, this blight is worst from September or the beginning of October, till the end of the season. The mosquito sometimes appears quite early in the season, and may even spread over a large area, but usually disappears again in an unaccountable manner.

Usual time of blight.

Remedies for mosquito are very difficult of application, chiefly from the fact that the pest appears at the height of the rainy season, and any liquid application is liable to be washed away as soon as it is put on, besides which, it is the season for manufacture, and there is the probability that some of the insecticide might be gathered with the leaves for making into tea.

Remedies.

In districts where the rainfall is not very heavy, some relief can be obtained by applying an insecticide immediately after a round of plucking, and then allowing sufficient time to elapse before plucking again, so as to insure that all leaves then taken off have grown since the application, and cannot have become tainted with it. The most effectual insecticide at present known is Kerosine Emulsion. Kerosine Emulsion has been found rather expensive in material and labour. Soap Solution is now strongly advocated by the Scientific Department of the I. T. A., with the suggestion that the spraying should be continued at intervals all the year round. This is a council of perfection in most cases, as labour for the purpose is not available; while on many estates the scarcity of water during the greater part of the year renders the work impossible.

Heavy pruning has no effect upon this pest. The same may be said of burning the prunings. The burning of prunings may to some extent mitigate the evil, but there are always remaining upon the bush an ample reserve

Heavy pruning. Burning prunings.

supply of eggs of the insect to ensure a most complete visitation of the pest during the succeeding season, if only the weather and other circumstances prove favourable for its development. It is no doubt for this reason that the custom of burning all prunings on certain estates has not been found of much use in diminishing ordinary pests and blights. Certain districts are more liable than others to attacks from mosquito, and certain blocks of an estate seem to get it more readily than others. If these blocks are watched and treated immediately the pest appears, the attack may be kept to some extent in check or its results somewhat minimized. Catching the insects by hand and destroying them, seems a very primitive way of dealing with tiny flies which can scarcely be seen; but some planters are of opinion that in the early stages of a visitation a great deal of good may be done in this way. Probably, where labour is plentiful, the children can be so employed with some profit, but in any case it can only be a palliative, and cannot be looked upon even as a remedy, much less as a complete cure.

Catching mosquitoes.

An interesting suggestion has been made that possibly this blight might be checked by the application of suitable chemical manure to the roots of the bushes. This is a method which has been successful in some other forms of agriculture; but has not yet proved successful in dealing with tea blights. For a time it was supposed that a liberal application of potash to the soil would banish the mosquito, but the experiments in this direction have not thus far been encouraging.

Light pruning.

If a garden is specially liable to this blight, it is a good plan to prune very lightly, at least every alternate year, so as to get an early crop, and to get a large proportion of the crop in the first flushes. This has been found in practice to answer well.

Whenever mosquito blight appears, close plucking may be resorted to. This will do very little harm to the bushes, as it usually comes after the middle of the growing season, and the bushes will have already made sufficient growth to prune upon. Some planters do not like to see the coolies bring in leaves which have been somewhat damaged by mosquito. Such leaves make very poor tea, but it is very desirable that they should be plucked off the bushes, because their stalks contain eggs of the insects, and if the bushes can be plucked close and clean, there is some hope of getting a fairly good flush afterwards.

Close plucking.

Leaf which has been much damaged by mosquito becomes quite black and crisp, almost exactly like manufactured tea in appearance, but it is of practically no value, because its sap has all been extracted.

Badly damaged leaf.

Green Fly, although really a pest, may be described as the tea-maker's friend. It is the only blight which does not injure the quality of leaf for manufacture ; on the contrary, a visitation of this insect is regarded as a sure promise of fine flavoury teas ; provided always that the attack is not so severe as to stop growth altogether ; in which case it is indeed a calamity. Green fly may be seen upon various kinds of shrubs besides tea. It appears on tea usually about the time when the second flush begins to grow, and may remain a month or so, or perhaps for the greater part of the season. Changes of weather seem to have little or no effect upon it. When the insect lays its eggs, it selects a bush here and there to be used as nurseries for the coming brood of flies which are to spread all over the block of tea. These bushes may be distinguished by the peculiar dry appearance of their leaves their colour is yellowish, and in course of time the

Green Fly.

Time of appearance.

Green Fly Nurseries.

older leaves assume a border of brown dry tissue all round them, being the result of loss of sap or fluid. A close examination of a bush in this condition will reveal the fact that there are multitudes of tiny insects busily engaged at extracting from the leaves the fluid upon which they are thriving. As soon as these baby insects gain sufficient strength, they spread to the adjoining bushes in every direction. At first they are very difficult to see, as they are shy of observation and very rapid in their movements. On the near approach of any one, they slip to the underside of the leaves with a peculiar and rapid motion sideways. When they get a little older, they begin to fly about, and, when in the most active stage, may be seen flitting about, with their peculiar erratic-looking zig-zag motion, a few inches above the level of the bushes. If a bush at this stage is shaken by a knock from a stick, a cloud of the insects will fly up and again settle in a new position.

The green fly feeds upon the watery fluid of the young leaves and extracts it in such a way as not to injure in any degree the tissue itself, or the actual juice or sap of the plant ; thus the juice, by losing nearly all its water, becomes greatly concentrated, and the whole leaf is proportionately contracted in size. Planters all know the peculiar stunted appearance of green fly leaf, and if the bushes are of small China variety, the leaves in these circumstances are so small as to be very difficult and expensive to gather ; they have also the light yellowish colour indicative of fine quality, and the sap is thick and sticky being really a concentrated essence of tea.

Essence of Tea.

When green fly blight becomes severe the growth of leaf is very seriously retarded, and the flies attack very young buds so that the shoots develop into a deformed shape and so destitute of fluid that many of the leaves fall off the stalk

Severe attacks.

as they open out from the bud, and then there is practically nothing whatever for the pluckers to gather. Bushes in this condition may truly be described as blighted. This is more common with the pure China variety than with plants of a higher class.

The illustration, Fig. 18, shows the effects of this blight. The shoot, marked No. 1, is the natural size; the other shoots are of the same class at different stages of blight, No. 5 being completely blighted.

Thrip.

Thrip is a pest whose ravages are hardly distinguishable from the effects of green fly. The leaves affected assume the same stunted appearance, and there is a similar shortage of crop; but there is this difference, that the action of thrip does not effect any improvement in quality: so that this pest has no redeeming feature. It is a tiny insect shaped like a torpedo; the form of which enables it to burrow between the unopened embryo leaves of a young leaf bud. In this situation it is secure from the influence of any insecticide which may be applied to the bush. Spraying with a strong solution of starch, or with rosin solution, was at one time expected to prove effective, by sealing up the leaves and so causing the mites to die of suffocation; but in practice the sealing film soon becomes broken under the influence of growth of the bud, and as a result there are always some survivals.

The damage is done by this pest while the leaves are in the embryo stage, so that when they develop and open out they are stunted in size, and a portion of each leaf, especially round the edges, is found to be of hard woody fibre, without sap, which is the chief characteristic of leaves affected by this pest. On estates at high altitudes this is by far the worst enemy with which tea has to contend. No effective remedy for it has yet been discovered.

Fig. 18.—Effects of Green Fly Blight.

Vegetable Parasites.—Besides the hosts of animated pests with which the tea plant has to contend, there are numerous enemies of a vegetable nature which fix themselves on leaf, stem, bark or root, retarding the healthy development of growth, and in some cases even strangling the plants which give them support.

Vegetable Parasites.

A great many of these parasites do but small injury to our plant, beyond causing it temporary or slight inconvenience, but there are some which cannot be treated with indifference, and the experience of other industries besides tea supplies ample warnings regarding the damage which may result from allowing certain blights of this kind to spread unchecked. Only a few of the most important vegetable blights can be noticed here; a fuller description can be found in the book on "The Pests and Blights of the Tea Plant" already referred to.

Grey blight.

Grey blight is a fungoid growth, which becomes attached to the tea leaf, and as it develops it sucks the sap from the portion of leaf over which it spreads, eventually resulting in a large brown blob of dead tissue. When a plot of tea is affected by this blight, it will be observed that many of the old leaves have these brown patches and some holes, which look as if the parts had been burnt by some kind of acid. The natives sometimes have an idea that it is caused by the droppings of certain birds. A close examination, however, will reveal the fact that the brown patches are covered by the lines of a fungus, arranged in a regular and beautiful pattern. When the fungus matures, it ripens its fruit, and the minute spores are carried hither and thither by the wind, to be deposited on hundreds of other leaves, and so spread the disease.

Spread of spores.

Certain authorities consider grey blight a most dangerous enemy, and recommend most stringent

measures for stamping it out; such as plucking off and burning all affected leaves, heavy pruning, etc. On the other hand, it may be mentioned that on some gardens this blight has been present for many years, but the amount of damage done has never been so great as to cause anxiety to the managers, or call for special measures of treatment.

Thread blight.

Thread blight.—It has been stated by some writers that the cause of thread blight is defective drainage. This is not so. Defective drainage probably predisposes a bush to this blight, as well as to many others, but the thread is found on bushes under all conditions, strong bushes being attacked as readily as weak ones. The only restriction thus far seems to be one of altitude, as it does not seem to exist anywhere above 4,500 feet.

Time of appearance.

The blight commences active growth in autumn, or towards the close of the rains, and makes its growth during winter, when the bush itself is in the inactive state. This remarkable fact seems to be applicable to various kinds of vegetable parasites. It feeds upon young twigs and leaves. The exact manner in which the blight is carried from one place to another does not yet seem to be known.

Position of attack.

In a new attack of an individual bush it appears at some point well up a branch—never near the ground. From this point the thread extends both upwards and downwards in the form of a bundle of white fibre, similar in size and appearance to *shoe thread.*

Mode of growth.

Its upward growth is rapid, and it has a wonderful power of adapting itself to the form of structure upon which it is growing; it spreads itself out on reaching a green stalk, covering the whole with a thin film; it makes its way along the rib on the underside of a leaf, from which it spreads into a thin mycelium, which completely covers that side of the leaf, from which it then extracts the sap. In this manner the

Fig. 19.—Thread Blight (*Stillbum Nomum*).
(*From " The Pests and Blights of the Tea Plant."*)

leaves are strangled, thus the twig dies, and in course of time, if unchecked, the branch dries up and the bush itself may be killed ; fortunately, however, this takes a number of years to accomplish. Some years seem to favour the growth and spread of thread blight more than others, but in any case when it attacks a bush, it has come to stay, unless effective measures are taken to destroy it. After having become sown or established on an individual bush, it spreads readily by direct contact. Whenever a blighted leaf touches a healthy one, the blight is communicated and spread. Wherever the bushes are large and the lines touching, this blight has a perfect field for its operations, and the threads spread from bush to bush with comparative rapidity, there being no break in the continuity of contact.

Contagion.

This blight attacks single bushes in the heart of a block of tea in the most unaccountable manner. After it begins on a block, bushes are attacked here and there far apart from one another until the block is dotted with blighted bushes like the spots on a leopard's skin. Each bush attacked becomes a centre of activity, affecting one or two or more bushes round it year by year, in an ever-widening circle, till the whole block is affected. As usual with fungus blights, the infection is conveyed by spores, minute seeds, which are carried from blighted bushes by means which are not yet manifest.

Mode of spreading.

Thread blight is probably the most insidious and deceptive of all the enemies of the tea plant. Its season of activity is from October to February only ; hence when the bushes have been treated for it, the planter fancies that he has succeeded, because in spring it has disappeared, and when in the turn of the season it turns up again, he naturally thinks that this is an entirely new attack ; whereas they

Deceptive character.

are the same bushes which harbour it year after year. This can be verified by marking the affected bushes with a piece of lacing wire or some such permanent mark.

Remedies.

The first remedy which suggests itself is to scrape the thread off with a bamboo knife, or rub it off with a wet cloth. It seems to come off more easily in the early stages, but after some years it becomes more adhesive. The scraping off prevents it from spreading for a time, and thus saves the branches from immediate destruction, but the thread scraped off seems to be but a *part* of the parasite, as it extends its ramifications into the inner side of the bark as well.

Rooted in bark.

This is illustrated by the fact that often when the blight has been dealt with effectively on the external surface, it appears in the following season growing upon the *new* wood only from the point where the section was made by pruning. Sometimes an affected bush has been watched at the season when the blight comes on in November, when a faint white streak has been observed on the bark throughout the line of former attack : this streak gradually becoming more distinct, till after a few weeks the thread blight was again in full growth.

Heavy pruning.

In the early stages of the disease, heavy pruning eradicates it, provided that the cutting be low enough to take away all the affected portions, and provided also that no affected leaves or twigs are left lying about on the surface of the ground. It is a safe plan to burn or carefully bury all the affected prunings and give the land a deep digging shortly after treatment.

Disinfection.

One fact which has been clearly established is that the thread blight exists only upon living tissue. As soon as an affected branch is severed from a bush, the thread upon that branch ceases to grow. When the branch is buried under the

soil, it rots in the usual course ; the thread does not affect any roots of bushes with which it may come in contact underground, nor does it spread to any healthy branches which may be buried in contact with the blighted branch. In this case it has been proved that the soil is a complete disinfectant.

If the thread has extended down the stem to the ground or near it, the difficulties of treatment increase, and if it extends *under* the ground to the roots, the case is rendered, so far as present investigation goes, well nigh desperate. Burning or singeing the bush *in situ* and then heavy pruning, is probably the most effective remedy yet applied, but it is a very severe one, and some less drastic remedy would be a real boon to the industry. The singeing must not be so severe as to kill the bush.

Singeing and heavy pruning.

The writer has seen a number of remedies tried with more or less effect, but none of them can be called a *cure*, unless applied in such a strong solution as to seriously impair the health of the bush itself. Some of these remedies are :—

Remedies tried.

Bordeaux Mixture.
Kerosine Emulsion.
Sulphur.
Lime.
Lime and Sulphur.
Red Lead Paint.

There is no prospect of this blight being permanently banished from our tea gardens, because it is to be found in forest jungle almost everywhere, and from there it will no doubt invade the tea cultivation again and again, even if temporarily overcome.

Blight in forest.

In the jungle its general features are the same as in tea. It attacks chiefly shrubs, brushwood and undergrowth, although it seems also very fond of mango and

pear trees, also certain forest trees, confining its operations to the small branches, twigs and leaves.

The fact that it does not spread over any large uninterrupted area of forest is perhaps explained by the fact that, being undisturbed by man, it rapidly kills the shrub which it attacks and the thread itself *dies with its victims.*

Stump Rot.

Stump rot is a fungus blight which invariably takes its rise on the stump of a tree which has been left to rot in the ground. Usually its presence is not indicated until after the lapse of two or three years, when it begins to attack the tea-bushes within the radius of the stump roots, killing them off one by one. The disease is known in Europe in various forms, and in England is known as Tree Root-rot. When a tree or bush has become slightly affected, the usual remedy is to scrape away the earth from the diseased part, and apply a mixture of equal parts of quicklime and powdered sulphur. To prevent the spread of the disease, the English Board of Agriculture recommend that a trench, nine inches deep, should be dug round the damaged and dead trees. The object of the trench is to intercept the spreading of the rhizomorphs, which travel underground about four inches below the surface. If an open trench is objectionable, they recommend that stout planks should be well coated with coal-tar, and let into the ground edgeways, thus forming an effective barrier to the spread of the fungus. This has been found very effective.

The vacant patch should be left fallow for at least a year ; then have a heavy dressing of lime, and deeply dug before replanting. All decaying roots which are dug up should of course be burned.

Blister.

Blister Blight has of late years demanded a good deal of attention. In the year 1908 it appeared in the Darjeeling District

for the first time, and has been endemic ever since. In certain parts of Assam this blight is epidemic almost annually, but it is limited to certain parts of the province and to the time of spring rains only as a rule. In some years it has been quite serious for a time. In the year of its appearance in Darjeeling it caused a great scare as the blight spread to every part of the district within two months of its first discovery. It now appears annually in violent form immediately after the first break of the monsoon and persists till the rains are over. In some shady places isolated blisters keep appearing at intervals throughout the year. The disturbing feature of this blight is the rapidity with which it can spread in favourable circumstances ; and therefore the possibilities of disaster involved in its recurrence. It is a fungus, and the spores, or seeds, which carry infection from place to place are so minute as to be discernible only with the aid of a very powerful microscope. These spores are produced in myriads by each blister ; hence the rapidity with which the disease spreads when circumstances favour it. A puff of wind passing over a blighted bush may carry infection over a whole block of tea, and a passing cloud may take with it a load of the disease germs for many miles, depositing them ultimately in quite unexpected places. This invisible dust is no doubt scattered over all sorts of vegetation during the season of activity ; but it can take effect only in favourable circumstances.

It has been found that only the underside of a tea leaf is pervious to the blight and, as a rule, only quite young leaves are affected. Sometimes, however, the blight finds a lodgment on older leaves and the writer has seen leaves which were six or eight weeks old badly blighted. Infection most commonly takes place when the leaf is in the embryo stage, just as it is opening away from the bud. At this stage it is the underside which is exposed, the leaf being in a vertical position. As every planter knows, the underside of a young leaf is covered

with a hairy fluff. It is on this fluff that the spore finds a lodgment. For its germination it requires moisture. A foggy condition of the atmosphere is peculiarly favourable for its development. This is why it has been found that a spell of sunny weather generally dispels the blight. Then the spore germinates, the root feels its way along the surface of the leaf, until it finds an opening into one of the stomata, and then it rapidly spreads root and branch, and so accomplishes its deadly work. The first indication of infection is a tiny round spot on the leaf, either pale green or pink. The pink colour is an indication of a very active or virulent type of the disease. As the roots of the fungus spread amongst the inner cells of the leaf, the fibre of the leaf is stretched to make room for the intruder. This causes the spot to swell and form a blister. The swelling is generally on the under side of the leaf; only very rarely is it on the upper side. When the swelling takes place underneath there is a corresponding depression on the upper side, and this is one of the indications of true blister blight. The size of each blister may be anything from a pinhead to half an inch. When the season for the blight is passing away, the new blisters are small. As the blister approaches maturity, the under side of it becomes covered with a white down, just like snow. This down is the flower of the fungus, and it is preparing a proportionately vast field of spores for disseminating the disease elsewhere. When several blisters become developed on a leaf, there is a tendency for them to coalesce and form one large blister, covering practically the whole leaf. After the spores of a blister have become mature, and get blown away, the blister itself dies, and the place becomes a piece of dead tissue. If several blisters occur on a leaf, the leaf dies.

When the disease is virulent, it attacks also the green stalks of the new shoots. In this case there is no blister, but the course of the disease is more rapid and destructive, for as soon as the roots of the fungus penetrate to the

centre of the stem, the flow of sap is stopped ; the whole shoot falls over and dies. This is the most serious aspect of the blight.

The places which are most liable to attack are shady or damp situations ; but after the blight has got a hold it is capable of spreading to all sorts of dry exposed places as well. The condition of leaf which favours the disease is a soft permeable surface. For this reason the soft Assam indigenous jat is the most liable to the disease. Heavily pruned bushes of all classes are similarly liable, and the destruction which can be accomplished on them within a short time is nothing short of appalling. The disease is also severe on young seedlings, and particularly so on new transplants. The reason for this doubtless is that the young leaves put forth by seedlings recently transplanted are feeble and thin of texture, forming an easy prey for the blight. However that may be, it is a fact that generally every leaf and bud as they appear become affected if there is any of the disease in the immediate neighbourhood. The natural result is that a considerable proportion of transplants are killed.

No cure has yet been found ; but repeated spraying with the old remedy known as Bordeaux Mixture has been found very useful in saving nurseries and heavily pruned tea from serious damage.

Lichen.

Tea is attacked by various kinds of *Lichen*, especially when in a weak or unhealthy state. Some people have an opinion that the lichen does no great harm to the bush; this idea being based upon the fact that in their native forests the indigenous tea trees are often found with their stems and branches more or less covered with the parasite. This does not prove anything, beyond the fact that a blight may attack plants in their indigenous as well as in a cultivated state.

Cause and sign of weakness.

The presence of lichen may be an indication of weakness, or it may be a cause of weakness. Both these statements may be taken as correct; the one result reacts upon the other. When bushes are subjected to severe or injudicious treatment, they become weak and pre-disposed to this blight, the spores of which germinate readily and find a suitable home upon the stems and branches of plants which are comparatively dry and are nearly destitute of leaves or natural shade. When once established, the lichen gradually extends its operations, covering the bark with its grey scales and embracing the whole with a tight merciless grip, extracting moisture from the plant, and at the same time excluding, to a very large extent, the light and air, which are so necessary.

Extreme cases.

In extreme cases the white or grey lichen spreads to the small twigs, killing many of them, and so nearly strangles the bush that the growth of leaf is quite infinitesimal.

One of the evils immediately resulting from the attack of lichen is that its scaly and overlapping leaves offer a suitable harbour for plant lice and many other insects which more or less damage the bark of our tea plant.

Bordeaux mixture, caustic wash, or soda ash, and other similar preparations have been recommended as remedies for lichen, but none are of such value as to be worth the cost of application, and in any case some scraping by hand has to be done.

Scraping.

The growth may be scraped off by hand without using any application; this is a slow process, however, and can only be undertaken in the slack season, when there is little else for the cooly children to do. It will be observed that the lichen comes off quite easily after a shower of rain; it then seems to relax its grip

and becomes quite soft, so that it can be rubbed off with a piece of gunny sacking or other coarse cloth.

Heavy pruning.

When tea is being heavily pruned, the opportunity should be taken to clean all the lichen and moss, etc., off the remaining branches, as it can then be most easily and thoroughly done.

When a block of weak tea receives specially generous treatment, such as top-dressing, deep cultivation, very light cropping, etc., the general improvement in the health of the bushes is followed immediately by a very marked diminution in the lichen and other kinds of fungi which may have established themselves upon the stems and branches.

Natural cure.

With returning vigour, the plants tend to throw these off in exactly the same manner as a patient sometimes, when treated to a change of air and diet, throws off disease without the aid of medicine or surgery.

When labour is available, a good many coolies may be advantageously employed at scraping lichen off the

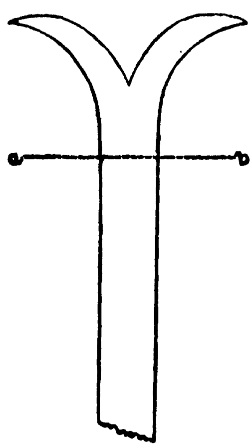


FIG 20.

stems and branches of the bushes. Any planter, who has not before tried this, will be astonished at the rapid improvement in health which will result. The scraping may be done with a piece of hoop iron, but a scraper, such as that shown in the accompanying sketch, can easily be made by a country blacksmith. The blade of a worn-out pruning knife is very suitable for making this scraper, which is here shown in full size. At the dotted line *a b*, the blade has to be bent back to an angle of 45 degrees from the straight. All the edges of the scraper should be blunt. It may be noted that a slight scraping of the outer bark is beneficial rather than otherwise to the health of the bush, provided always that the scraping is not deep. It is well that the scraper should have a suitable handle, as a cooly can do more work with an implement which does not hurt his hand.

Self shade.

Suitable shade helps very much to keep down all kinds of lichen, hence it is desirable always to keep the bushes well covered with leaves and especially to avoid cutting entirely away the twigs and leaves which grow inside the bushes for their protection.

Moss.

Moss gives trouble chiefly at high altitudes on hill gardens. It does not hinder growth of leaf to such an extent as lichen, but when bushes get old, and especially if the climate be very cold and wet, it is apt to become very troublesome, and it may even grow up to the very tips of the leaves and stop growth almost entirely. A periodical cleaning off seems to be the only treatment for it.

A very useful implement for cleaning away moss can be made of finely split bamboo, tied up into a bundle, something like the brush which Native women use for the hair. This brushes away the moss very effectively from the small twigs, and it is also useful for cleaning

away various kinds of lichen and fungi from the stems of the bushes. To do this work thoroughly is very expensive, but it is also of great value.

A very useful kind of brush can be made from a woven wire material known as File Cleaning Card. This can be cut into strips measuring 1 by 2 inches, and nailed to pieces of stick, which form handles for the brushes.

Spraying with a solution of soda ash, kills off moss to a large extent.

Hail.—Although hail is not usually reckoned as a blight, yet it is certainly very blighting in its effects, especially when it falls over a large area, and the question of how to treat the bushes afterwards is sometimes of very great importance.

Causes of hail.

The usual time for a serious fall of hail is at the end of April, or during the month of May, when the weather has become very hot and the atmosphere liable to thunder-storms. A change of pressure in the atmosphere causes an alteration in the position of the clouds, which again may cause a violent disturbance of the currents at different altitudes; the greatly-heated air from warm regions is thus suddenly brought into contact with a very cold current; a sudden fall of temperature is the result, the air is no longer capable of sustaining so large a quantity of moisture and precipitates it upon the ground. Under ordinary circumstances this water falls in the form of heavy rain, being the well-known thunder shower; but it happens at rare intervals that the descending moisture has to pass through an exceedingly cold current of air which freezes it into solid lumps of hail, the size of the lumps being larger or smaller according to the denseness of the moisture which was falling.

Very large stones.

Very large stones have sometimes been known to fall, occasionally being as much as one and half inches in diameter, tearing off large branches of tea by the force of their impact. Such

a fall is not of very great importance, however, because unless on very rare occasions the area over which such heavy stones fall is not great, and although the damage inflicted upon the bushes may be very considerable, yet their number is so small that even if left entirely unplucked for the rest of the season, there would be no considerable loss of crop. The size of ordinary hail is from $\frac{1}{4}''$ to $\frac{1}{2}''$ in diameter, and when the area affected is large, and the fall is thick and continuous for more than half a minute, the damage to tea-bushes is always very serious. It is not only that the growing flush is destroyed, the chief damage is sustained by the light twigs and branches, which have been either torn off, or their bark so lacerated and wounded that they will take months to heal again.

Gardens specially liable.

Some gardens are much more liable to hailstorms than others, especially certain hill gardens, owing to the formation of the neighbouring mountains and their influence upon the direction of air currents ; these gardens almost invariably suffer from hailstorms every time the season comes round.

Light pruning.

The best way to deal with such gardens is to prune lightly, and grow comparatively little in the first part of the season, so as to get the first flush off before the season for hail comes on. The bushes must in this case have more growth allowed them during the later flushes.

Not many gardens are liable to suffer by hail throughout their entire area ; it is usually only one spur or division which is smitten during a storm. The same storm may, however, affect a long line of country in a peculiar way. On one occasion a very severe storm swept over a part of the Darjeeling and Dooars district in a narrow line of about half a mile, or a mile in width and extending to forty or fifty miles long. Along the

course of this storm all houses had the windows on the exposed side completely denuded of glass, and the tea-bushes stripped of leaves and small twigs, the ground under the bushes being literally strewn with the debris.

Treatment.

When bushes have been severely smitten by hail, the wreck looks very appalling, and it is no wonder that some planters have been tempted to think that the only way to get them into condition again is to re-prune them. This is a mistake, especially if the tea is at a high altitude where growth is slow. If in good cultivation and general health, the bushes will soon begin to throw out a new flush; it is then very important to allow the flush to grow well before plucking, so that new wood may be formed before the bush is made to yield much crop; this is made necessary by the fact that all the young soft bark existing at the time of the storm has been more or less damaged. If at this stage anything like hard or close plucking is resorted to, the crop of the succeeding year will suffer seriously.

The tea made from leaf grown after severe hail is invariably of poor quality. It seems that the tea bush makes a special effort to cover itself quickly with leaves and so replace the breathing organs which have been destroyed. At the same time the new growth is crude, as the sap producing it had been insufficiently digested.

Goats sometimes develop a fondness for tea bark, especially billy-goats, and have been known to eat great patches of bark off the bushes in a block adjoining cooly lines. After the bark is gone, a certain portion of the wood begins to rot; this enable white-ants to find a lodgment, and they soon increase the damage. The ants usually get all the blame for such havoc, but white-ants feed only upon dead tissue, and there is always some special reason for their presence

White-ants.

on a tea-bush; their operations, however, always tend to widen and increase any wounds which may have been inflicted.

The most useful remedy against *insect pests* is *Kerosine Emulsion* which is prepared as follows :—

Remedies.

From one to two pounds of ordinary country soap are boiled with one gallon of water till thoroughly dissolved. To this, while still almost boiling, two gallons of low quality Kerosine or Paraffin Oil are added slowly, the whole being thoroughly mixed with a syringe during the mixing. It then forms a creamy, almost buttery, mass. The mixture is then allowed to cool, and when cool, is made up with water to thirty gallons, and after thorough mixing can then be applied.

For *fungus blights* generally the remedy most in favour is Bordeaux Mixture. The formula for its preparation varies greatly with different authorities. The Scientific Department has at different times suggested from $1\frac{1}{2}$ lbs. to fully 6 lbs. of Copper sulphate per 100 gallons of water.

The British Board of Agriculture recommends the fo

Formula suggested for Thread Blight.

Soda Ash ..	.. 6 lbs.
Lime, freshly slaked	.. 4 lbs.
Water ..	.. 10 gallons.

Apply with a soft brush after pruning.

No iron or tin vessels should be allowed.

Note.—For use upon stems or branches of tea during the inactive season, the mixture can be applied double strength.

CHAPTER XIII.

FORESTRY.

No tea estate can afford to be without forest. The quantity of forest produce necessary for the efficient working of an estate is much greater than people generally suppose. Taking, for instance, an estate with one thousand acres under tea, producing six maunds of tea per acre, the annual requirements for the factory are something like 30,000 maunds (or 1,000 tons) of firewood, besides timber for the erection of buildings of various kinds, factory, out-houses, bungalows, cooly lines, etc., and there is also required an unceasing supply of small timber to a staff of at least two thousand people of all grades, who must have the necessary fuel to cook their food and for domestic purposes generally. Where little or no forest exists, the estate has to purchase fuel for factory use, and may even have to bring coal for this purpose from a long distance at great expense; it has also to purchase all timber necessary for buildings, and perhaps has to go to the enormous cost of importing iron structures from England, while the coolies on the estate have to use as fuel any rubbish which they can find, which probably means that much of their food has to be cooked with dried cow-dung—a state of things which does not tend to make the place a favourite one with labour.

Fuel for factory.

It is pitiable to think of the hundreds, and even thousands, of acres of valuable forest which have been recklessly and needlessly swept away from many estates in all the tea districts. This has resulted either from the carelessness of those in charge, from inability to appreciate the value

Waste of forest.

of the property, or from sheer ignorance of the general principles of forestry.

Effects upon climate.

The experience of the Forest Department in India has added testimony to the fact, which has long been known, that the deforestation of a province has a very marked detrimental effect upon the climate and rainfall, while, if the whole country is completely denuded of forest, the result is practically ruin, at least from an agricultural point of view.

Mr. Ribbentrop, in his " Forestry in British India," mentions many instances of this, including great portions of North Africa, Persia, and Hindustan.

Spring rains.

The spring rains in the Assam Valley are chiefly attributed to clouds formed by evaporation from the large area under forest, so that, if deprived of this source of moisture, and dependent only upon rain brought from the ocean by the regular monsoon, the tea estates of Assam would soon be in a much less flourishing condition than at present.

Forest reservoirs.

When the monsoon pours its beneficent showers over the country, the portion which falls upon open ground soon disappears. Part of it sinks into the soil, while part is at once carried off by streams and rivers to the sea. The rain which falls upon forest land is received into a sort of reservoir; it is detained by dense vegetation from flowing rapidly off the surface; it is retained by the mass of roots underground; and it sinks down deeper than in open country. When dry weather sets in, the land in the open gets rapidly dried up; whereas it has been proved by actual investigation that the evaporation from forest land is from 62 to 84 per cent. less rapid. The beneficial effects of closed forests are much greater than with open forests where grazing is allowed, where the undergrowth is more

Evaporation.

or less destroyed. Throughout the dry season the forests continue to give out their reserves of moisture, thus modifying the atmospheric condition and causing the formation of rain-clouds at the time when rain is of the greatest possible value.

Hill forests.

In mountainous regions, the necessity for a large area of forest becomes all the greater for experience has proved that where too large a proportion of the mountain sides has been cleared, the steeper slopes become much more liable to suffer from landslips during heavy rain, there being nothing to hold the water in check; the streams become torrents, and the rivers develop into devastating floods. All the water being thus rapidly drained off the land, the dry weather becomes a season of severe drought, during which all classes of cultivation suffer more or less.

From all this it follows that when people become possessed of great tracts of hill country and then proceed to destroy all, or nearly all, the forest thereon, they not only court disaster for themselves, but they also cause serious damage to all neighbouring property.

Effect upon dividends.

Apart from these wider considerations, the existence of suitable forest, in good yielding condition, has a very real and immediate effect upon profits and dividends; hence some knowledge of forestry is quite imperative for the manager, who is to work his estate to the best advantage.

As a question of mere profit and loss, it is perhaps somewhat startling to know that the Forest Department of India now makes a clear profit annually of something over seventy-six lakhs of rupees, or fully five hundred thousand pounds sterling; this after charging all salaries of European and Native staffs and other expenses of working.

Sylviculture and Arboriculture.

Sylviculture refers to the mere preservation and protection of existing forest; fencing where necessary, cutting creepers which

threaten to strangle trees, preventing grazing and fires, thinning out, etc. *Arboriculture* means the planting of new forest, or planting up of bare patches, and otherwise making use of waste ground for forest purposes.

On most tea estates, sylviculture is all that can be attempted, but even in the matter of planting new land it is wonderful what a lot can be done with a very small expenditure, or with practically no expenditure to the estate, because the labour at this work is expended mostly at a time when there is nothing else pressing for attention. In this matter what is required is knowledge and care on the part of the management, rather than expenditure of any considerable sums of money.

Grazing.

Grazing, or rather *browsing*, is of all things most destructive to forests, short of actually cutting down the trees. The worst browsing is that of buffaloes, cows next, and goats a good third. If any considerable number of animals are allowed to graze in a piece of forest, it is quite hopeless to expect young trees ever to come up to take the place of the mature ones which die or have to be cut down; hence no coolies should be allowed to keep grazing animals, unless perhaps on grass land, or on a suitable block set apart for the purpose. Cowherds are very fond of cutting down the branches of certain trees for stall-feeding, and if allowed to do so, they soon cause great damage and destruction.

Cow-sheds.

On no account whatever should cowherds be allowed to build sheds in any part of the forest, because the immediate effect of this is a rapid and complete destruction of every living thing in the neighbourhood of the hut.

Fires.

At the dry season of the year there is great difficulty in preserving forests from fire, the more especially as all cowherds make a practice of firing land where their animals are allowed to

graze, in order that they may get the fresh young grass and herbage which springs up almost immediately after a fire has passed over the land. When once such a fire has been started it may spread and stretch away for many miles if not checked. Wherever the fire goes, it destroys at least seventy-five per cent. of all the young saplings, besides more or less seriously damaging the bark of large trees. The few saplings which are not actually killed emerge from the ordeal in a very crippled state, and so damaged that it is doubtful if many of them will ever develop into good sawing timber.

Fire lines.

As a protection for standing forest, as well as thatching grass, etc., it is necessary to cut a fire line all round it in the autumn or early winter; this will soon dry artificially, and can be burnt before the grass of the preserve itself is dry enough to ignite; so in this way a line or a ring of bare ground is formed, which becomes a zone of safety from the inroads of fire from neighbouring properties.

Creepers.

Many fine young timber trees are killed or maimed annually by the action of enormous creepers which gradually thicken and tighten their grip till they have obtained the mastery. It is the custom of the Indian Forest Department to send a few men round the forests once a year, with hatchets, to cut such creepers; one snip with the hatchet is usually enough to rid a young tree of its enemy for a good many years at least.

It is a mistake to suppose that the best way to preserve or improve a forest is by simply letting it alone.

Value of cropping.

In most cases a little cropping where judiciously done, results in great improvement; it must, however, be done systematically and under proper supervision. When trees come to maturity and reach a certain age, they practically cease to increase in bulk or produce timber, and are taking up

ground which can be occupied to better advantage by new seedlings. For this reason it is advisable that mature trees should be made use of from time to time, and the young seedlings around get a chance to expand. In cutting out mature trees, one important matter has to be borne in mind; a supply of seed is always necessary for renewals by self-sowing in the forest, so that if all mature

Seed trees.

trees are removed, the future of the forest is sure to suffer; hence at least one large tree must be left at intervals in order to secure the necessary supply of seed.

Where young forest has become at all dense, it is very important to have the trees thinned out to a suitable distance; care must always be exercised to avoid

Canopy.

extremes in this matter Foresters make it a rule to preserve as nearly as possible a complete canopy of foliage overhead. It is always reckoned a test of a carefully worked forest that no great portion of sky can be seen from any place on the ground. In thinning out, of course all the worse kinds of trees as well as crooked and crabbed specimens will be taken out by preference.

Working plans.

If a forest is to be worked to the best advantage, it is quite necessary to begin by framing a working plan by which a definite portion will be treated annually, leaving the remainder untouched, so that the whole may be gone over in routine during a cycle of years. Even in the matter of cropping bamboos, if the details of the work cannot be carefully watched, a great deal of good will be done by confining the cutters to certain blocks of forest in each year, giving the other blocks time to recover from any injudicious or rough treatment to which they may have been subjected.

Coppicing.

In some cases a scarcity of financial resources may perhaps render it necessary to crop young forest for fuel to tide over a temporary difficulty. It will then be advisable to *coppice*

the trees, that is to cut them down at about five feet from the ground, with the intention that the stumps should throw out new branches and again become trees. This is often done with great success in some parts of England. There are some kinds of trees which stand coppicing very well, and produce in course of time perhaps as heavy a weight of timber for fuel, etc., as those which have been left to grow in natural form from the first; but it must be remembered that such trees can never be expected to form into thick timber suitable for sawing into beams and rafters for building purposes.

The ideal system of coppicing is that the trees should be cut down close to the ground in which case the new shoots which develop spring from the level of the ground, and soon form roots of their own, so that in this way each new shoot becomes practically a new tree, irrespective of the stool from which it has sprung. The one drawback to this is that not every kind of tree can stand such severe coppicing; and if there is danger of the tree itself dying under the operation, it is better to coppice high. It is only by actual experiment that a decision can be made as to whether in any case the trees may be safely cut down to the ground.

Standards.

According to the experience of Indian Foresters, it is not advisable to coppice the whole of the trees in any block at one time; it is better to leave what are called standards at frequent intervals. This means that trees are to be left standing untouched at intervals of not more than forty or fifty feet, in order to provide some shade for the new growth when it begins.

For the purpose of coppicing, it is a good plan to divide the forest into about twenty blocks; then each year one block is to be coppiced in succession; so that, by the time that the turn of the first block comes round again, there will be sufficient new growth for recutting.

The coppicing should be limited to trees having a girth of not less than eighteen inches.

When it is intended to cut mature timber either for sawing into scantlings or for fuel, it is very desirable that such timber should be thoroughly dry before being put into use. The usual custom is to cut while green and stack it to dry; a cheaper and much more efficient way is to girdle or ring the standing trees about a year before they are required, or even a month or two before; if the trees are of a soft nature, they will then dry themselves almost completely before the circulation of sap ceases. Ringing or girdling may be described thus. A belt of bark is cut off the trunk of the tree at a point near the ground, the ring of bark measuring about eighteen inches wide right round the trunk; a deep ring is then cut into the sap wood all round the centre of this belt, but this ring need not be wider than a few inches. The sap of the tree continues to rise as before up the channels in the sap wood of the trunk and so on to the branches and leaves, then starts on its return journey down between the bark and sap wood, but is arrested at the point where the ring has been cut away, and so being prevented from returning to the roots, it is carried off into the atmosphere by evaporation. This process of partial circulation goes on until practically the whole of the sap in the trunk and roots has been extracted and the tree expires. A curious fact in connection with this matter is that, if a comparatively young tree is cut clean off, it will almost certainly grow again from the stump, but if it is ringed in the manner described above, a gradual decline and death is sure to supervene.

Girdling.

There are some kinds of trees, however, with soft and very sappy wood, such as the *Simal*, which are difficult to kill even by ringing, because the flow of sap downwards from the upper edge of the wound is so abundant that it soon bridges over the gap at one or

two points, forms new bark over the wound, and so establishes complete circulation again.

Thatching grass.

Every tea estate should have a good supply of thatching grass; if none is found on the place, it should be planted without delay. It may, of course, grow on poor land, but it cannot succeed well or yield good crops year after year unless on good soil. A hot, dry climate is best.

Time of cutting.

Thatching grass should be cut when fully ripe, but must not be allowed to stand until it begins to redden and decay; in this case it will not last long or make good thatch. It may be cut and left to dry for a few days on the ground, then bundled, and brought in. If bundled in a green undried state, it will ferment and spoil, or if stacked in great heaps, the same result will follow. The bundles may be made to stand on end, supporting each other in a circle until required for use; if rain falls meanwhile, care must be taken to have the bundles turned over and dried before rotting sets in.

Cultivation.

Thatch fields require to be annually cleaned of extraneous plants and roots, shortly after reaping, and an occasional burning and a rough digging greatly improves their condition.

Bamboos.

Everyone is aware that the bamboo can be put to many uses. On a tea estate it is indispensable and invaluable. It is a species of grass. There are many varieties of bamboo, from those which may be described as annuals to certain hard and valuable kinds, which live for perhaps a hundred years or more.

Bamboo seed planting.

The bamboo gives flower and seed only once just before it dies, so that the more valuable varieties are very seldom seen in flower. The usual way of planting bamboos is by offshoots, or suckers; hence it is commonly supposed that this is the only way, which is a mistake.

Bamboo seed is very small, and is so enveloped in scale after scale of husk that the seed itself may very readily be overlooked. When planted fresh, it germinates readily within two or three weeks. The seedlings are easy to transplant, but should not be removed to the forest until the second year. In five or six years each plant will have become a clump of useful bamboos.

Planting offshoots.

In planting offshoots, a young bamboo about a year, or at most two years old, is selected at the outer ring of a clump, and cut back to *not less* than eight feet from the ground. The earth is then carefully removed and the stump is severed at the junction with the parent clump, care being taken to preserve the rootlets intact, and not to damage the eyes which may be seen all round the root of the offshoot itself. In planting these bamboos there are several elements which are essential to complete success

1. The ground must be thoroughly wet.

2. The offshoot should not be shortened too closely eight to ten feet all over is necessary.

3. Plant about two feet deep, in good soil, and the stump sloping about forty-five degrees from the level (so as to encourage the flow of sap) similarly to the way of planting cuttings of roses, etc.

Offshoots give a crop of bamboos a year or two sooner than plants from seed, but their great disadvantage is that they will live only as long as the parent clump from which they have been detached ; thus if the parent clump flowers and dies three years afterwards, so will the offshoots which were taken from it, whereas plants grown from seed are certain to have the full span of life before them.

Growth of the bamboo.

When a clump of bamboos is in full vigour, it sends out its new offshoots in July or August ; these come mostly from the eyes at the root of the previous year's new bamboos ; hence they

may be expected chiefly at the circumference of the clump. These offshoots come away very rapidly and all at the same time, so that at that season of the year a clump of bamboos in good health presents a curious sight, with all these young tips bursting out of the ground like enormous stalks of asparagus, which they exactly resemble. They do not come up in a thin state and afterwards expand, as some people suppose; they are practically as thick at the start as they will ever be, but are so soft and succulent that they can be pulled to pieces by hand or knocked over by a slight kick of the foot.

Young shoots edible.

It should be noted that any shoot which is broken off at this stage is done for, and the remainder of the stalk at once dies down. Coolies are very fond of tearing off these tips for cooking and eating; every one so treated means a bamboo lost. The Chinese use the offshoots of a certain kind of bamboo for including in the well-known preserve called *chow-chow*.

Rapid growth.

The offshoots grow upwards very rapidly, often as much as twelve inches or more in the twenty-four hours, growth being mostly at night, so that they attain to their full height in about a month or six weeks from the start, and in the month of September these new bamboos may be observed with tall bare stalks towering straight above the rest of the clump and waving in the wind. The clump has now grown its crop of bamboos for the year, but these new bamboos have to be covered with branches and leaves, which are gradually developed as the months go on, and at the same time the fibre of their stalks gradually hardens and matures.

Cropping.

In cropping bamboos it is of the greatest importance that some care should be exercised in the selection. Garden coolies naturally prefer to cut those at the outside of the clump because

they are easily got at, but these are exactly the ones which should not be cut, for they contain the embryo eyes of the current year's offshoots, and it is very seldom that the eyes develop at all after the parent bamboo has been cut away. Besides this, the outside bamboos are probably too young and succulent for ordinary purposes and they will not last so long as those in the interior of the clump, which are three or more years old, with very hard strong fibre. If the clumps are merely thinned out, taking some annually from the densest parts, and sparing especially those of the outer ring, the yearly crop from each clump in full bearing will be not less than from fifteen to twenty bamboos.

Cutting Implement.

The ordinary cooly's knife is not suitable for cutting out bamboos from a clump, neither is a saw applicable. The best implement is a wood chisel, with a broad point and a long handle. This can easily be made of flat steel 2 × ¼ × 9 inches long. The point of this has to be beaten out to 2½ or 3 inches wide, and the head shaped and inserted into a wooden or bamboo handle about 3½ feet long. This implement is used as a crowbar, and is wonderfully efficient.

Moonshine.

The natives have a theory that if bamboos are cut at full moon they will not last so long as those cut at new moon. There is something in this, because moonshine has certainly an effect upon growth; this has been recorded in many countries. It is probable that the bamboo is more *sappy* during full moon than at other times; hence an excess of sap at the time of cutting would cause it to rot sooner.

Preserving bamboos.

It may again be noted here that the natives of Bengal have a system of preserving or curing bamboos, by steeping them, immediately after cutting, in a pond of muddy water, for two or three months, after which they prove much more lasting and withstand rot for a long time.

Planting trees.

If it is intended to plant out new forest or to fill up open spaces, a great deal of labour and disappointment, as well as expense, may be saved by first considering well as to what particular kinds of trees may be planted with a prospect of success. It would be folly to try to plant on a large scale anything which would be unsuited to the climate of the place, while, on the other hand, it would be almost equally foolish to plant trees of low value and of very limited usefulness, merely because the planting would be easy.

Wild seedlings.

Sometimes really good and useful kinds of trees may be found growing in neighbouring forests, and it will always be safe to make use of the best kinds of these. It is doubtful policy, however, to transplant from existing forests any seedlings which have grown up from seeds self-sown. These are necessarily delicate, having grown in the shade of trees and shrubs, and their roots but ill-developed because of the entire absence of cultivation.

Nurseries.

It is better, where necessary, to make small nurseries here and there, as near as possible to the required spot, and grow the plants from fresh seed. The seedlings may afterwards be transplanted during the rains, or during the cold weather, with large unbroken balls of earth, the latter for preference.

Grevillea.

The *Grevillea* or Silver Oak is recommended as a most useful tree for any moderately warm climate, and can be grown even at an altitude of four or five thousand feet. It grows rapidly, has a very handsome appearance, and yields excellent timber either for fuel or for building purposes. It is, however, slow of germination and difficult to handle. Seed is not plentiful and is therefore rather expensive. In some climates the *Grevillea* is liable to a fungus blight which attacks the leaves, and eventually kills the young

tree. Dusting with sulphur is a preventive. The tree thrives well in rich light soil, or with abundance of manure.

Oak.

For hill estates the various kinds of Oak and Chestnut are always good ; some of the varieties indigenous on the Khassia Hills grow very rapidly, yielding excellent timber, and have been introduced to other districts with great success. There are different varieties suited to different altitudes. Khassia Oak does not succeed on poor soil. Walnuts also grow easily and rapidly without much trouble at elevations between 3,000 and 6,000 feet. The best method to grow Walnuts is to put the seeds into germinating beds about November. They sprout in February or March, when they can be planted out with certainty of success. The Walnut grows very rapidly in good soil. The Sikkim Walnut has a very hard shell, but germinates readily without any special treatment. The timber from it is very valuable. *Pinus longifolia* grows well in some hill districts, yielding good timber for boards. It grows at an elevation of 1,000 feet upwards.

Walnut.

Pinus longifolia.

Cryptomeria.

Cryptomeria grows readily in hill climates, but the timber is not greatly valued. It does not make good firewood, although the young branches burn well. All the conifers grow readily in poor soil.

Toon.

There are some kinds of trees which have to be reared in nurseries and are improved by transplanting, but there are others, such as the *Toon* or Indian Cedar, which do not stand transplanting at all well. The *Toon* tree yields such a valuable timber for box boards, etc., that it is worth a good deal of care and expense in order to rear it satisfactorily. It grows on the plains, and up to 4,000 feet. The most successful way to plant *Toon* is to form little *thullies* or

spot terraces on the spots where the trees are to grow; after a shower of rain sprinkle a few seeds (which are very small) on the surface of the ground, cover lightly with fine soil and then with some soft grass to keep off the rays of the sun. When the seedlings come up, thin out and keep free of weeds. Keep off all goats or similar animals, which are all exceedingly fond of toon leaves. *Toon* may also be transplanted successfully in the cold season with unbroken balls of earth.

Perhaps the best tree for planting on the hills is the *pipli* (*Bucklandia populnea*). It grows rapidly, even on poor soil, is evergreen, and one of the handsomest-looking trees of the forest. The timber is very valuable, almost as hard as *Sal*, and finer grained. It stands shade well, but cannot be grown at all where grazing is allowed, as the young trees bleed almost to death every time the tips are eaten off.

Dibbling.

There are some kinds of trees, such as the Oak and Walnut, which do not require to be brought up in nurseries, and are indeed much better to be sown, *in situ*, by dibbling. Sometimes they are first germinated in hotbeds, but even this is not necessary if the seed is quite fresh and climate or land is at all moist. The experience of the Forest Department has gone to show that walnut seed, if fresh, scarcely ever fails to germinate. It is merely dibbled by placing in a hole, shell and all as it is, and covered with an inch or so of soil.

Mixed forests.

Forests composed of only one kind of tree always *look* best, but better ultimate results are obtained by planting various kinds together, because different classes of trees extract different kinds of nourishment from the soil, and with a mixture all the soil constituents are made use of to their full extent.

Distance apart.

Trees should be planted quite close at the start, say 5 by 5 feet, and thinned out afterwards as they develop.

The importance of this is that they draw one another up and form straight boles. If too wide apart, they will develop side branches, which is very undesirable.

Scrub.

Planting up bare land is a very difficult and slow process because most forest trees naturally require some shade, and the young plants become stunted by exposure to the full rays of the sun. The best plan is to plant scrub forest first; which is formed by putting in cuttings or seeds of rapid-growing, indigenous scrub; then the timber trees are planted at regular intervals. Perhaps the best arrangement for the trees is to plant lines 20 feet apart, and 5 feet between the plants in the lines. This allows ample for failures, and the trees will ultimately be thinned out to about 20 by 20 feet.

Capital cost.

In planting forest, a very important consideration is the amount of original expenditure. Many foresters advocate planting trees very closely, even 2 by 2 feet at the start; but when it is reckoned that the forest cannot yield any return till after the lapse of twenty years, and there cannot possibly be any sawing timber till after eighty years or more, the original expenditure may by that time become a very serious item. Even a moderate sum at compound interest for eighty years figures out a very large amount. In most circumstances the expense of planting closely, all things considered, renders it quite prohibitive. The closer the planting, and the longer the delay in thinning out, the more certainty of ultimately growing tall, straight trees with clean boles; but at the same time, the growth is proportionately slow, because the roots of all the trees are contending for the small amount of soil available, and the growth of one and all is retarded. In all kinds of agriculture it is now a recognised fact that overcrowding is a serious hindrance to root growth and plant development.

Overcrowding.

CHAPTER XIV.

TEA MANUFACTURE—PLUCKING LEAF.

Functions of leaves.

As the tea bush is grown with the sole object of producing leaves, it is of the utmost importance that the planter should fully appreciate the functions which leaves perform in the general economy of plant growth. No system of cropping or treatment can be correct or fully remunerative unless in full sympathy with the principles which govern the production of leaf.

Although every one knows that all kinds of plants are more or less dependent upon their leaves for some sort of respiration, yet people do not generally appreciate the importance of the functions which leaves perform in the economy of a plant. The activities of a plant are mostly exhibited at its extremities. While the roots absorb plant food from the soil in a fluid state and send it up the stem, such food is nevertheless in a form which is quite unfit for assimilation until it has been elaborated in the cells of the leaves, where it is treated under the influence of sunlight in the atmosphere.

The process is quite interesting, and shows that the leaves are of more importance to the plant than any other part of its structure. This is a fact which must appeal to tea planters, whose whole industry is bound up in the production of tea leaves. The leaves are quite as needful to the plant, however, as to the planter himself; and things are calculated to run smoothly only when the planter recognises this community of interest, and allows the plant to retain its fair share in due season.

An eminent scientist in horticulture wrote long ago :—" Strip the leaves off a tree and no more wood

will appear until the leaves are restored; feed its roots in the hope of thus compensating for the loss of its leaves and the stem will be filled with watery matter, but the latter will collect in the interior until it forces its way through the bark, and runs down in putrid streams, as happens to the mulberry-tree when it is incessantly stripped for silk-worms, and as occurs to trees whose leaves are continually destroyed by a noxious atmosphere. Strip the ripening green grapes of their green garments and no colour or sweetness will be collected in their berries. Rob the potato of its foliage, and you will seek in vain for nourishment in its tubers; and so of all things else." It is true that fruit-growers at certain seasons resort to defoliation or summer-pruning, but only to a partial extent, for the definite purpose of letting a little sunshine reach fruit or wood. It is a well-known fact that if a fruit branch is denuded of leaves, either by hand or by insect pest, the fruit must inevitably die and drop off. Gardeners all know that a plant is healthy in proportion to the quantity of its foliage. If a fruit tree shows signs of exhaustion the gardener nips off more or less of the young fruit, perhaps all of it, for one year, in order that all nourishment elaborated by the leaves may go to restore the failing health of the plant. The scientific study of forestry has demonstrated, among other things, that the formation of timber in a tree is in proportion to the extent of its foliage. In rubber trees also, the quantity of latex secreted is in proportion to the crown of the trees. If a tree is stripped of some of its branches, the thickening of timber during the succeeding year is proportionately reduced. Exactly the same thing happens if a tree becomes infested by insect pests which strip it of leaves during the growing season.

Observant planters must have noticed that tea bushes which have been left for seed, and allowed to grow naturally year after year without pruning or plucking, make much more growth of wood than those which are

regularly pruned and cropped; the collars and stems of the former are of much greater girth than the latter of the same age. The reasons are not far to seek. When spring comes round, the bush throws out a flush of leaf by which it means to sustain life, and form a laboratory for the elaboration of nourishment with which to increase its general bulk. Meanwhile, the planter comes along and removes some of these leaves, with the result that the nourishment from the remaining leaves, instead of going towards increasing the general structure, is largely used for the formation of other leaves to take the place of those which have been lost. And so the process goes on throughout the season, the planter's aim always being to preserve the balance of things, and not overdo it by being too greedy at any particular time. If he takes too many leaves at any time, the daily functions of his bush will be impaired, its root power will be sensibly diminished, and the future crops will proportionately suffer.

Growth of wood.

Incidentally, it may be pointed out that the bush, which has by pruning been kept comparatively small and low, does not require nearly so much nourishment for the support of its structure as the unpruned tree standing 25 feet high, with proportionate stem and branches all demanding a share of whatever sap may be collected by the roots and elaborated by the leaves. Hence it may be said that one of the objects in pruning a bush and keeping it of a moderate size is to induce it to use its powers for the production of a succession of flushes of leaf rather than for the building up of a large structure of fibre and wood.

Defoliation.

An evergreen plant or tree is always seen to be covered more or less with a mantle of green leaves. But they are not always the *same* leaves. This is a fact which is not readily noted by the casual observer. During the season of

activity the tree produces new leaves at its outer extremities, and it casts off the old leaves in succession, as they are no longer required. At the point where an old leaf has been cast off to-day there is a green stalk ; in a few months it will be a twig, whose epidermis has become bark ; in course of years the twig may become a branch, and finally a great arm of a wide-spreading tree. Thus the tree expands and increases in every direction ; preserving all the while its crown of green foliage ; but the foliage is always under process of renewal, while every part of the tree is changing in character or size.

The difference between evergreen and deciduous trees is not that the former retain their leaves all the time, but that while in leaf all the time they cast off and renew their leaves individually ; whereas the latter class cast them off all at one time, becoming naked for a season. The general impression is that all deciduous trees shed their leaves in autumn ; and that the reason is to be found in the approach of winter. The prime reason is quite different, however. It is simply that in course of time the leaves become effete and useless ; they have to be cast off some time, and the autumn season is the most suitable for most trees in cold and temperate climates. In India, the phenomena of natural defoliation present many interesting characteristics. The *Pipal* tree (*Ficus religiosa*) preserves its beautiful foliage throughout the winter ; then in spring, when all other vegetation is bursting into new growth, it sheds its leaves and takes on a dried-up look for a time. Similarly, the *Toon* tree (*Cedrela toona*) sheds its leaves in August, becoming naked and apparently dead at the very time when almost all other vegetation is making the most luxuriant and rapid growth. From September onward the *Toon* rapidly covers itself again with the beautiful, dense, dark foliage for which it is so distinguished.

It is a well-known fact that "the leaf of a plant is its lungs and stomach." The leaf performs the functions

of respiration, perspiration and digestion, aided by the influence of solar light and heat. One of the products of its activity is oxygen gas, which it diffuses or breathes into the atmosphere; while the crude sap which was brought up from the roots is changed chemically, and fitted for carrying nourishment to every part of the plant.

It is an interesting fact that the exhalations of leaves are the very breath of life to the world.

Effete leaves.

The point of practical importance to note here is that in the performance of these important functions the delicate structure of the leaf soon becomes worn out, the cells become clogged and the leaf is no longer able to discharge its duties efficiently; hence it is that the old, effete leaves are cast off, their places being taken by the freshly constructed leaves which form, as it were, a new generation of workers.

When the tea grower plucks leaves from his bush, he is bound to do it with some consideration; for, as Professor Lindley says, "whatever tends to impede the free action of leaves, tends also to diminish the healthiness of a plant." Some leaf must in any case be allowed to remain upon a bush if the latter is expected to continue growing. Just how much leaf may be taken with impunity is the question to be faced at all times. For the bush itself old leaves are better than none, but a certain proportion of fresh young ones is imperatively necessary if it is to remain in health.

Unpruned tea.

When a plot of tea has been left unpruned for two years and then pruned down to just one or two eyes above the former cutting, it will be found that the bushes are rendered practically leafless; in fact, they present rather a shocking appearance. The reason, however, is a perfectly natural one. During the last year's growth the bushes had cast off all the old, effete leaves of two years ago in preference

for the younger and more useful ones which had just been formed. This had probably been facilitated by the effect of shade ; but the mere fact of the bush being naked under such circumstances is not an indication of weakness. When old leaves are retained on a bush for an abnormally long time, it indicates that the bush, or the particular branch, is in a semi-dormant state, and is unable to launch out into new growth.

Plucking machine.

Plucking is one of the operations on a tea estate which must be done by manual labour. A plucking machine was indeed invented many years ago, but it has met with very little favour, and can only be employed for the manufacture of coarse tea. No machine has yet been invented which will *select* from each bush the leaf to be plucked and leave what should be left.

Flushes.

The tea bush is said to *flush* when growth begins, and one who is watching it day by day in spring can see the beautiful bright green of the new leaves gradually developing all over its surface. The second flush is the growth from the axil, or node, between a leaf and stalk of the first flush ; the third flush is similarly produced from the second, and so on.

Number of flushes.

Number of pluckings.

There are probably not more than ten or fifteen flushes in the year from even the strongest bushes, although a garden has to be plucked all round about thirty or thirty-five times in the course of the year. Every shoot is not ready for plucking at each time of going round, because all are not equally vigorous ; and it is for this reason that, although the first and second flushes are easily distinguishable, it is impossible to tell the individual flushes after that. Each shoot must be allowed to grow until ready, and it must be plucked immediately after it is ready.

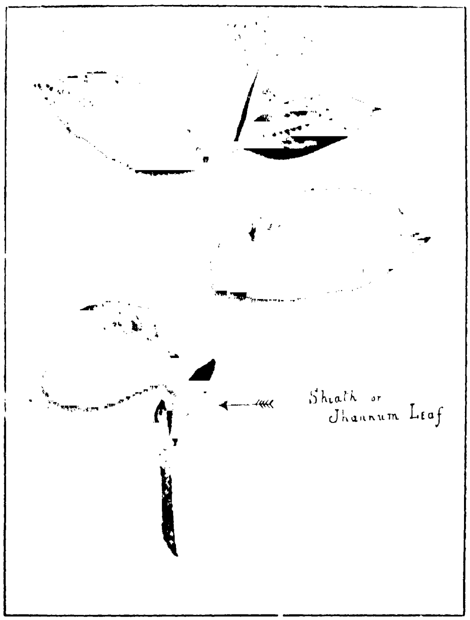


Fig. 21.—First Flush.

Hard plucking may be described as a system of plucking with the object of obtaining the largest possible crop from the bushes, in the present, irrespective of the garden's future. This is a policy which, unless in very exceptional circumstances, cannot be too severely condemned, and should never be adopted unless with the full consent of the proprietors. It may be necessary once in the history of an estate to force bushes to yield for a time the greatest crop possible in order to tide over a pressing financial difficulty, but such a period of pressure is inevitably followed by a general falling-off in the health of the plants, unless they get a rest with special nourishment after the temporary difficulty is over.

Close plucking.

The term *close* plucking is adopted to distinguish a system which now obtains on many estates, and which is chiefly responsible for the serious falling-off in quantity produced from the older gardens in several of the tea districts, and it is also in many instances responsible for a similar falling-off in quality of the teas produced.

Close plucking may be described as plucking off the shoots whilst still very young and leaving scarcely anything of new growth on the bushes. This is done with the object of making as fine tea as possible at all costs.

Given a garden in fine healthy condition, the adoption of the system of close plucking will be highly successful for one or two years ; there will be fine teas and a fairly large quantity, but after a time the vigour begins to abate, the quantity becomes less and less, and then the quality also suffers, and the property generally gets into a very unsatisfactory state.

Managing Agents, as well as Directors, are much to blame in this matter. The cry has been for fine teas at whatever cost, and the peculiarities of the market for the past few years have supported this policy. If fine teas are produced, no questions are asked, present

dividends being the only consideration. As a result of this policy there are at the present moment many gardens yielding only 3½ to 4 maunds of very ordinary tea per acre, but which ought to be giving between 5 and 6 maunds, or even more, of teas at least fully as good. The bushes have become enfeebled and are unable to give either quantity or quality. Even in such circumstances, however, if the property is intrinsically good, a course of *liberal* treatment would before long produce satisfactory results.

Fall in yield.

The bud represents the finest tea, the leaf next to it being not so fine, and the others coarser as they are situated remote from the bud. In coarse plucking, the bud and three or more leaves are taken, whilst in fine plucking not more than the bud and two leaves are plucked ; some managers pluck only the bud and one leaf.

Classes of leaf.

Coarse plucking means a comparatively large crop, whereas fine plucking means a restricted crop with better quality. It is possible, however, with ordinary fine plucking—the bud and two leaves, carefully and judiciously carried out—to make a fairly large crop of tea, almost as fine as the garden is capable of producing.

The *quality* of tea is determined by other considerations besides the smallness of the leaf—that is a *comparative* test—the necessary elements are *flavour* and *strength*, both of which are chiefly dependent upon climate and soil, although in a large degree also upon the general treatment of the bushes and of the leaf, in field and factory.

Quality.

Some of the general characteristics of fine tea will be mentioned later on when dealing with the details of manufacture.

In the different tea districts, the quantity of tea produced per acre varies very much, and even within each district the

Quantity per acre.

variation in quantity as well as quality is considerable. Thus in the Darjeeling district some gardens yield as low as 2 maunds and even less per mature acre, whilst others go as high as 6 maunds of fine tea. In Assam, Dooars, Sylhet, etc., the range is from 3 maunds to 10 maunds, and individual gardens have been known to yield as much as 22 maunds for one or two years.

Taking 5 maunds per acre as the general yield, this means an annual *green* crop of something like 14¼ cwts., a quantity which agriculturists would not consider excessive or exhausting to the soil. This fact is made still more prominent when we remember that it takes six bushes a whole year to produce one pound of tea, so that each bush produces only 2½ ounces of tea per annum. It must be remembered, however, that tea is a permanent fixture in the ground, and there is no possibility of any renovation of the soil by rotation of crops.

Crop from each bush.

In plucking young bushes the question of crop should be a very secondary matter. The chief object is to train the plant into a healthy bush. It is a mistake to allow it to grow to an abnormal height before plucking, just as it is a mistake to pluck too soon. In the early plucking a measure should be used, two feet being a good height to begin with, and to be increased as the season goes on. On no account should a healthy young plant be allowed to grow higher than 2½ feet before plucking; it is necessary to check the growth in the centre, and force the energies of the plant towards the side branches.

Plucking young bushes.

When plucking the scond flush from young tea, at least two fully developed new leaves should be left. The system throughout the cropping season should be to go round often, plucking only the strong or high shoots which are ready, leaving entirely the weak side branches. Good new growth must be left at each plucking. It is bad policy to leave

Leaving alone.

young tea entirely alone to grow as it may, with tl object of letting it gather strength ; this will only rend it necessary to employ more severe measures in prunin and it will be the longer before the bush becom properly formed.

Liberal treatment.

If the desire is to be specially liberal to young te it is best to pluck as directed abov but take only the bud, or the bud an one leaf at each plucking. In this way the sap will l diverted as necessary, with a minimum of shock to th plant.

Cropping mature tea.

There is no garden where the growth of first flus comes on absolutely evenly ; som bushes will be ready for plucking befor others ; constant care and close supervision is necessar in order to have the plucking done systematically. Thi applies to the first flush especially, but not by any mean exclusively.

First flush.

In plucking the first flush, the general rule is to leav three fully developed leaves on the bush. This i exclusive of the sheath leaf, which i variously described as the *jhannur garbi*, or *ranipat.* The bud and two leaves should b taken, the stalk being cut immediately below the secon leaf, as shown by dotted line in the illustration facin this page. (Fig. 22.)

As little stalk as possible should be taken ; it is mos undesirable in the tea, as tea buyers consider its presenc objectionable.

Cutting the leaf.

A custom very generally followed at one time was t take a portion of the third leaf as wel as the first two, leaving on the stall only a small portion of the leaf to protect the eye or axi where the embryo of the future flush is contained. Th idea in this is to add to the crop, and still leave th necessary number of eyes for the coming flush. This however, is leaving out of view the functions which the new

Fig. 22.—First Plucking.

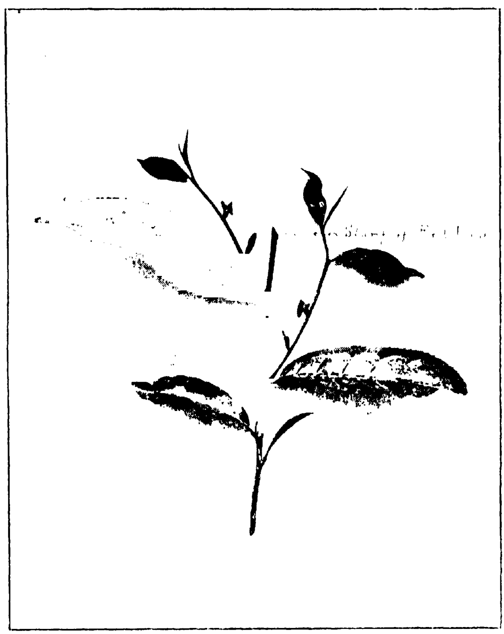


Fig. 23.—Second Flush.

leaves perform in the economy of the plant as already described. A sufficient number of leaves are necessary for the supply of nourishment to the bush, and the stump of leaf which is left in this instance is a hindrance instead of a help to the general health. Besides this, the mutilated leaf which is taken is a direct source of injury to the whole of the tea manufactured, and reduces its value to an extent which is not made up by the supposed increase in quantity.

Mutilated leaf.

From the second flush on till the end of July, or later, the rule should be to *leave, at every plucking, one fully developed leaf, besides the jhannum.* On the rule being strictly adhered to with the modifications noted below, much of the success of the season depends. The stronger bushes at all times grow more rapidly than the weaker ones, and they must not be allowed to run too long before being plucked.

Subsequent flushes.

For this reason it is necessary at some seasons of the year to pluck round the whole garden every five, six, or seven days ; care being taken always that the system is thoroughly carried out, no single shoot having *more* left on it and no shoot having *less.*

Frequency of plucking.

The modifications of this rule are as follows :—

1. When a new shoot has grown from a terminal which was formerly banjy, it should be plucked to the *jhannum* as shown by the dotted line in the illustration.

2. Sometimes three new shoots come from one axil. The *centre* one of these may be taken without leaving a leaf as soon as it has sufficiently grown and developed.

3. Sometimes a bush throws out specially vigorous shoots, near the base of which succession (growing) buds are formed.

Succession buds.

All such may be plucked (as shown by dotted line in the illustration) as soon as the bud and two leaves are fully developed on the main shoots. As a result of this, the succession buds will rapidly develop into a new flush.

Necessity for system.

It would seem a little difficult to accomplish all this in detail, when one remembers that in every 500 acres of tea there are more than a million bushes; and there are many branches and twigs on each bush; but with a good labour staff it can be done to a wonderful degree of accuracy, if it is *insisted* on, and the overseers are systematically trained to understand that it must be done. It may be thought by some that this system does not allow for sufficient growth being left on the bushes in the second and third flushes. It will be observed, however, that the eye at the *jhannum* leaf usually develops into a flush as well as that of the leaf above it: hence, there are *two eyes* left at each plucking. When properly carried out, the rule to leave one fully developed leaf is both simple and sufficient. This is just one of the points upon which it is not enough merely to issue orders. The manager and his assistants should daily make it their business to see that the system is being adhered to.

The experienced planter can easily tell by examination of bushes recently plucked whether the orders have been carried out with sufficient care. Such examination constantly done is of much greater value to the management than merely watching individual coolies at work.

A rush of leaf.

There are occasions now and again, during the height of the season, when climatic conditions seem to combine to force growth, and leaf comes out with a *rush*. The manager who has his work at heart will always be on the look-out for this; constant observation and experience will enable him to notice the first indications of a rush of leaf and to take the necessary measures to meet it in time.

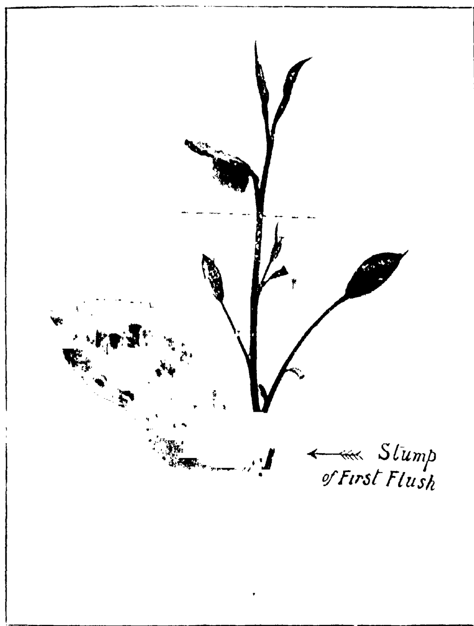


Fig. 24.—Second Flush with Succession Buds.

Moonlight.

It has often been observed that *moonlight* has a direct influence upon the growth of leaf, and, other things being equal, the heaviest flushes are gathered at the time of full moon.

Overgrown flushes.

If the flush is by any means allowed to get "ahead" of the pluckers, there will be splendid loads of leaf brought in, and it may be that the manager will rejoice in the capital manner in which the garden is forging ahead, but as he has to leave two or three leaves all over when there should be only one left, there will come a time of reckoning when the flush is off. The extra leaves left on the bushes will require time to mature before a new flush can come away, and the quantity produced during the following week will be diminished in consequence.

These remarks are specially applicable to the months of August, September, and October.

Plucking to the jhannum.

From the 1st August or 1st September, as the case may be (or even later), plucking all strong bushes to the *jhannum*, or *close plucking*, may be resorted to. From this time forward the question of *quality* may be reckoned as of first importance. All strong bushes will have by this time abundant foliage on which to subsist, and they cannot be seriously injured, however close the subsequent plucking may be. The growth of each shoot is now comparatively slow, owing to the multitude of eyes from which growth can come, consequently the sap is thick and the quality good, even if the leaf may be quite small.

Slow growth.

Young leaf.

In the early months of the rains there is a great temptation to pluck leaf which is still too young. Specially fine plucking at that time can only lead to disappointment: the sap in the bush is watery and the growth rapid, hence the shoot must reach a certain stage of development before the

influences of evaporation, etc., have sufficiently thickened the sap in the leaf to render it capable of being turned into good tea. On every consideration it may be concluded that to pluck very young shoots any time before the end of July is nothing short of " killing the goose which lays the golden eggs."

Weak bushes.

Wherever bushes have become weak, from whatever cause, they must be left uncropped entirely, until they regain sufficient strength. A dressing of manure or some stimulant during the off season, may be beneficial, but in any case they should not be plucked. A good plan is to avoid plucking or *pruning* them for one or two years until they get quite high ; then *cut them well down*, and again avoid plucking until good strong branches have been formed. It is not enough to leave a weak bush unpruned, or to prune it very high and then pluck it like the rest of the garden : the only way to enable it to gather strength is to leave it unplucked. In order to have the weak bushes properly saved, some planters mark each one with a long stake ; this may do very well so long as the stake remains, but coolies find such stakes very useful for firewood, and when the stake is gone, a plucker cannot be blamed for plucking the weak bush. By far the most effective and satisfactory way is to drill the overseers and coolies (especially the former) into a thorough understanding of what must be done.

Staking.

Heavily pruned bushes.

After bushes have been heavily pruned, it is, of course, necessary that they should be allowed to put on special growth.

The best way to ensure their being properly spared during plucking is to select a few good pluckers for the work under a reliable overseer, and give each plucker a stick, as measure, so that the bushes will be plucked evenly to a certain height from the ground.

Planters have sometimes given a small stick, say 9 inches long, with which to measure each shoot from its base, but this is impracticable.

Height. With hybrid tea a good height to begin with is 2 feet 3 inches or 2 feet 6 inches, to be increased after three or four weeks. The object of increasing the measure is that the weaker bushes which come on later will thus undergo less cropping.

Special overseer. The overseer at this work should not be changed week by week, but should be held responsible in case of bad work being done. A special overseer should be detailed for this work always.

A policy of drift. Some managers make it a rule not to touch heavily pruned bushes till July. This is a policy of drift, it is not management. By that time the stronger bushes have run to an abnormal height, and when tipping is begun, it is too late to divert the sap into the side branches, so that by the end of the season the strong bushes have not spread properly, and the pruning has to be done on half a dozen of very thick sticks instead of a wide bush with branches of uniform strength, while the weaker bushes, which flushed later, have been overcropped and their wood is consequently poor and thin.

Close plucking. There is no more direct way to ruin a tea garden than by close plucking on the top of heavy pruning.

The tea bush is wonderfully tenacious of life after having got a grip of the ground, but, short of actually uprooting it, this is the most effective way to destroy or to permanently injure its vitality.

Ill-treatment. It has been a custom, almost universal, to pluck very hard any particular plot which has been selected for heavy pruning during the succeeding cold weather. Such ill-treatment is, however, manifestly out of place for plants which are

destined to undergo a severe shock, and is quite against the natural order of things.

What surgeon would prescribe for his patient a course of low diet and hard debilitating work as preparation for undergoing a severe operation ? And yet this is exactly the treatment which the planter usually prescribes for his wretched bush which has got seedy, or out of form, or bark bound, or for some such reason is diagnosed as requiring to undergo the partial or complete amputation of all its limbs. All bushes which are destined for heavy pruning should have at least as generous treatment as the rest of the garden. This is no mere theory ; it has been put to the test of practice again and again, and the remarkably free and vigorous growth after pruning has proved the wisdom of it. There is not likely to be much *banjy* from a bush which has been specially well grown previous to heavy pruning. Many persons seem to overlook the fact that the tea bush is "a thing of life" and this mistake is doubtless at the root of much of the ill-treatment to which it is often subjected.

Hard plucking.

During the second year after heavy pruning it is customary to pluck the bushes hard. This is again a mistake, and is the chief cause of the utterly wrecked appearance of some plots of tea several years after heavy pruning.

The blame is sometimes laid upon the pruning, whereas it is the vicious system of plucking which is at fault. Even if the bushes, after the first year, have been left unpruned, or only slashed across the top, they should be treated in the matter of plucking exactly like the ordinary tea, unless perhaps in the first flush when one leaf less of new growth may be left.

Banjy.

Banjy leaf has often been a source of heartbreak to the planter. Many have been the devices tried, both in pruning and plucking, with a view to eliminating it. Much of the

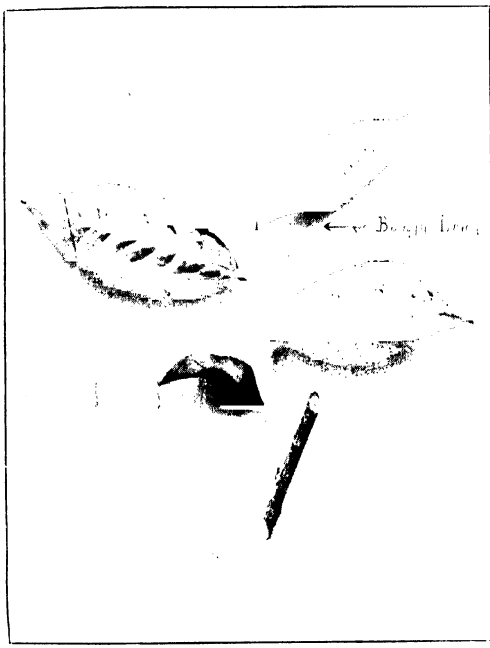


Fig. 25--Banjy Shoot.

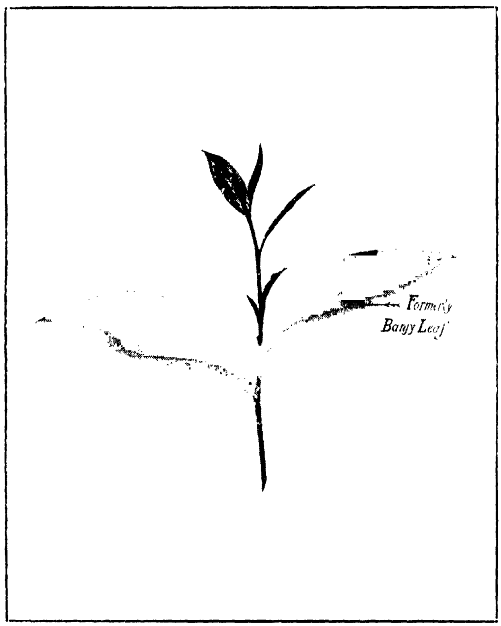


Fig. 26—Growth from Banjy.

anxiety on the subject has been quite misplaced, however, and has arisen from a mistaken idea both as to its cause and its results.

Banjy is a resting leaf, and is formed at the extremity of a shoot when the branch has expended all its energy and growing power for the time being, and must be looked on as in some sense a sign of weakness, although not necessarily a proof of the bush itself being weak. It may be from sheer weakness, or it may be that the flush has been allowed by neglect, or intention, to grow abnormally long, in which case it is simply a result of excessive growth.

Flush from banjy.

A very common fallacy has been to suppose that a *banjy* shoot will never flush again during the current season until the leaf at the extremity has been taken off, and in carrying out this idea, the weak bushes, which can only grow *banjy*, are worried to death. It is very singular how planters of many years' experience hold tenaciously to this erroneous theory, the more especially as it can be so easily tested in the early months of any season. The theory, no doubt, had its origin in the idea which was universally held in the early days of tea-planting in India, that some of the *old* leaves of the bush must be plucked at the same time as the young in order to stimulate the bush to further growth. The idea came from China, and was one of the wrinkles which the wily Chinaman gave when asked to teach the Britisher how to compete with him.

Plucking old leaves.

Growth.

When growth begins from a *banjy* shoot, the tiny embryo bud at the base of the *banjy* leaf begins to swell exactly like the eye at the axil between an ordinary leaf and stalk. The bud gradually opens out and forms a new flush, with a *jhannum* or sheath leaf, the same as an ordinary flush.

Weakness.

If a shoot has gone *banjy* because the bush is weak, and unable to produce more than, say, three leaves in the first flush, it is the height of folly to pluck the *banjy* off; such treatment may, like lashing a half-dead horse, force the bush to a desperate effort; but can only result in a further weakening of the bush and consequent shorter crop in the coming months.

Banjy after heavy pruning.

It is no unusual thing for a plot of tea which has been heavily pruned to suffer from a combination of causes, especially from drought, so that before the shoots have attained a sufficient height for plucking, the whole has gone *banjy*. For a manager to start and pluck off such *banjy* is nothing less than suicidal. The labour would be infinitely better employed at digging and pulverizing round the bushes, or, if that has all been already done thoroughly, better let them dig in the river bed or anywhere rather than destroy the health of the bushes by plucking when a season of rest is clearly indicated. If the necessary rest is given, the subsequent results will be very gratifying.

Rest.

Recuperation.

It need not be supposed that while the plant is thus apparently resting it is really dormant or inactive. In all probability its roots are being extended and the tiny rootlets are spreading their ramifications and absorbing what nourishment they can, which nourishment is being carried up the stem, and digested by the leaves in preparation for further upward growth.

Seedling.

In reference to this question it is interesting to watch the growth of a young seedling. Upward growth is by no means continuous. After three or four leaves have been formed, the uppermost leaf becomes *banjy*; this is followed by a period of apparent rest, but in reality the energies of the young

plant are being fully employed in developing, expanding, and ripening the leaves already formed, and so preparing for a further upward rush. After a time growth begins again at the axil of the *banjy* leaf, and four or five more leaves are rapidly formed and the growth again becomes *banjy*, followed by a season of rest and development.

The number of leaves formed at each successive spurt of growth is greater or less according to the robustness of the plant or the fertility of the soil.

Plucking banjy.

Banjy leaf may be plucked if the bush is strong and there is sufficient growth below it; provided it is taken in time and the leaf itself is soft.

When plucking *banjy* it is advisable to take a little piece of the stalk with it, to ensure that the leaf is not broken. Broken and detached leaves go largely to form what is called " Red leaf " in tea.

Inside leaf.

Many years ago a very ingenious method was adopted by a well-known planter in order to force his bushes to give the largest yield possible; this was to pluck all open or *banjy* leaf in the *inside* of the bushes during the first flush, allowing all growing shoots to run to a certain extent. This system is still followed by some planters, although the originator of it gave it up long ago, after the season of special difficulty for his company was tided over. While the bushes are strong and vigorous, especially if of China *jat*, and the pruning has been light, such treatment forces the bushes to flush beyond their powers of endurance; but the system cannot be followed with advantage for more than two or three years, because the bushes suffer from the strain and become more and more debilitated as the branches get more naked, and they then fall an easy prey to any and every kind of blight.

Stripping.

In the early days of tea planting in India a system was borrowed from China of taking three crops of leaf in the season; the system having been to let the shoots run to a considerable length, making perhaps ten or twelve leaves, after which a gang of coolies was sent round to *strip* them, leaving the bare stalks. On some gardens a modification of this system still exists; when a good flush is on, the coolies may be seen taking the stems between the fingers, palm upwards; then the hand is brought up with a sudden jerk, stripping off the leaves and the soft end of the shoot as well. This is the way to make a large crop of coarse tea.

Coarse tea.

Weak plots.

In the height of the season when the flushes are vigorous and growth rapid, it is sometimes impossible with an ordinary labour force to get round the garden quickly enough to keep abreast with the growth of leaf. On such occasions it is a good plan to pass over whole plots, where the bushes are comparatively weak, and so give such plots the whole benefit of the extra growth, while the labour is available to crop fully the stronger portions of the garden. Meanwhile a great portion of the leaf on these weaker plots will "run out" and become *banjy*. This need cause no anxiety; if a flush is lost on such plots, there will be a gain in general health, and when some leaf *must* be lost it is better to let the weak plots have the benefit.

Protection from sun.

While the plucker is at work, it is of great importance to shield the leaf which has already been plucked from the influence of the sun. Every cooly should have some sort of cover for the basket, the simplest and most efficient being a strip of cloth; this is neither clumsy nor heavy. When there is plenty of leaf, it is a good plan to give each plucker *two* baskets, a large and a small one, or get the pluckers to empty their baskets occasionally, spreading the leaf loosely on a cloth under the shade of a dense tree.

Carrying leaf in cloths.

The practice of carrying a cloth in the form of a bag in front of the body instead of using a basket is most pernicious, as the leaf is too confined, and very readily gets more or less fermented and spoilt. This can be verified by the planter if he puts a handful of leaf into his pocket, and examines it an hour afterwards. The edges of many of the leaves will have assumed a brown tint, and the whole leaf will have contracted a nasty stuffy scent, a sure sign of incipient fermentation. No cooly should on any account be allowed to carry leaf in the form of a *bundle* in front of her.

Fermented leaf.

When leaf is kept for some time in a large quantity densely packed, the natural transpiration goes on, but without access to the air it causes a process of fermentation to take place. The leaf gets intensely hot, and, when opened out, emits steam, and the whole of the leaf thus influenced is found to have turned to a bright copper colour. This fermentation produces a totally different result from the fermentation or oxidation induced during manufacture; it is probably due to the fact that bacterial action and decomposition has set in. All leaf which has become fermented in this way is not only useless, but is a source of great injury to any tea with which it may get mixed. Whenever discovered, every fermented leaf should be carefully picked out of the load and thrown away. A sudden fall of rain during the afternoon of a hot day is very apt to spoil in this way a good deal of leaf in the pluckers' baskets, and it is well to make the coolies turn over their leaf lightly every now and again to prevent heating and consequent damage.

When leaf which has thus become discoloured is examined under a microscope, it is found that the cells have all become ruptured, and the sap has by some means been lost. The bright coppery colour of the leaf at this stage would naturally lead one to suppose that it would

make the finest tea ; but, as every planter of experience knows, the reverse is the case. The explanation is to be found in the fact that the sap is gone, and there can be no tea without sap. When such leaf is placed upon the withering racks, it does not wilt or wither like ordinary leaf ; it shrivels up crisp, the reason again being found due to the absence of sap.

Weighing twice.

Whenever possible, the leaf should be brought into the factory at least twice a day. In hot climates it is now customary to weigh several times a day, and on hill gardens it has been found both practical and economical to weigh at midday as well as in the evening. To facilitate this work small sheds are erected at intervals throughout the garden, either on roads or on vacant spaces adjacent ; one shed for every 40 or 50 acres. When the time arrives each gang of coolies has its leaf weighed at the shed most convenient. The leaf is then spread upon the floor for a short time, in order to aërate it, then it is carried by ponies, or other method, to the factory.

Extra pice.

There are very few estates where the labour staff is sufficient without special concessions or inducements to get the leaf plucked rapidly enough during the busy season. Sometimes with a short labour force, and a spell of specially good growing weather, the manager is almost driven to distraction as he sees a thick flush of leaf literally waving in the wind and the plucking staff hopelessly unable to keep pace with the growth, and falling steadily behind. Instead of getting round the garden in six or seven days it becomes eight, nine, or ten days, or even more ; then the planter despairs of obtaining quality for a time. As a special inducement to rapid work, the giving of extra pice for all leaf plucked over a certain task is almost universal. The amount of task is fixed according to circumstances, and the extra may be at the rate of one pice per lb. or two pice for three

pounds, etc., according to the amount of leaf available. When plucking for pice, it is quite marvellous how rapidly an experienced plucker will work, both hands going, so that the eye can hardly follow the movements, and yet the leaf is being all the time selected quite carefully. A few managers object to giving extra pice, as they say that they are unable to keep the coolies from plucking coarse leaf and maltreating the bushes. It must be conceded that when giving extra pice the difficulties in the way of careful work are greatly increased, but the earnest manager will not hestitate to give the extra care and attention required in order to ensure success; and experience has shown that it is possible to get really fine leaf, and good careful work, even when giving extra pice for months together.

Difficulties.

Leaf Weighment.

Leaf weighment is one of the most important features of the day's work. It cannot be done properly by a writer or any person who is wholly employed in the factory, and who is thus quite unacquainted with the conditions under which the leaf for the day has been gathered. It is naturally the duty of the assistant to weigh the leaf which has been plucked under his own supervision, and as he weighs each individual load, he is able to judge whether the cooly has done a fair day's work, and how much, or if any, extra pice should be given. One cooly may bring in a large load with little effort, when another, whose task has been on a somewhat barren block, may bring but very little as the result of a really hard day's work. A word of encouragement or censure, where necessary, goes a long way towards producing satisfactory results on the succeeding day.

Duty of Assistant.

A careful examination of leaf, load by load, before weighment, is of primary importance. In this work each assistant can be

Examination.

helped by some reliable native overseer, although such help should not be felt to remove entirely the assistant's own eyes from the task. Anything like coarse leaf should be scrupulously eliminated ; a few coarse leaves will vitiate a whole basketful of tea, because during manufacture the juice of all is expressed, and the coarse mixes to some extent with the fine, injuring the flavour of the whole.

Plucking buds.

In examining leaf, it is important to make sure that no cooly has been plucking young buds, and so destroying the prospects for the coming week. There is much more importance in this matter than many planters are aware of, especially about the time of the second flush ,if the prevailing desire is above all things to make fine tea ; or at times when leaf is rather scarce and crop falling behind, and there exists a general anxiety to force immediate results:

Fermented leaf.

Punishment, in some form of fine, should be meted out without hesitation to any cooly who has allowed any portion of her leaf to become fermented by heating in the basket. The bright red colour and objectionable odour of this readily betrays its presence. Similarly, a fine must be inflicted either by withholding extra pice or reducing the day's pay, when leaf has carelessly been exposed to the direct action of the sun, and so become scorched or partially withered.

Scorched leaf.

Trickery.

Whenever leaf weighment is done in a careless or perfunctory manner, the coolies soon display their marvellous ingenuity for taking advantage. The basket of leaf will be dipped in water to make the whole weigh heavier and so add to the extra pice ; a stone or a brick will be hidden amongst the leaf, or a false bottom may be constructed so as to conceal a permanent addition to the weight ; in some instances the basket itself is skilfully doubled

or very heavy bamboo supports added to it on the plea of strengthening it.

Most of these dodges can be counteracted by having the leaf turned out and weighed in a separate basket; this takes more time, however, and the leaf is liable to suffer from the extra handling.

Bruised leaf.

At this stage, the handling of leaf requires great care. The slightest bruise breaks some of the leaf cells; this damage is not at once apparent, because discoloration takes time, but it begins immediately after the bruise is done and the sap is exposed to the action of the atmosphere, resulting in more or less damage to the tea.

CHAPTER XV.

WITHERING.

WHILE the assistants are engaged in examining and weighing leaf, the manager, or the factory assistant, has his hands full attending to the proper spreading of the same for withering, which is the first process of manufacture. This process may perhaps be described as the most important of all, although there is no department of factory work which can in any sense be left to itself.

Spreading leaf.

The manager who has a proper interest in his work will throw the best of his energies and his utmost skill into the supervision of every detail in the factory; so much depends upon the workers being kept strictly up to the mark and prevented from falling into slovenly ways, or even into grooves and beaten paths.

Objects of withering.

One of the objects of withering is that the leaf may be prepared for the subsequent processes of manufacture. Were rolling attempted before withering, the result would soon be a mass of torn fragments and the juice nearly all spilt and lost. About 75 per cent. of the fresh leaf consists of water even on a dry day, and nearly half of this has to be got rid of before the fibre of the leaf and stalk will stand the strain of rolling without breaking up. An important chemical change also takes place during the process of withering, as Dr. Mann has pointed out, whereby the natural enzyme or fermenting principle is greatly developed and increased, thereby adding materially to the flavour and strength of the manufactured tea.

Enzyme.

Wire netting.

There is a general tendency amongst planters to favour the idea that wire netting forms the best surface upon which to wither leaf. It is very expensive, which consideration alone should make people hesitate before committing themselves to it on a large scale, and it is not so very permanent as may at first sight be supposed.

If stretched in long tiers, the swinging and beating to which it is subjected in order to get the leaf off is a great strain upon the material, which after a few years gets torn into fragments. There is much to recommend the wire. If properly disposed, the leaf will wither upon it much more rapidly than upon anything else, and it has the strong recommendation that it is fire-proof; but, all things considered, it is not the best material for the purpose. If any heat has to be employed for the withering, the wire attracts this and causes blackening of the tender leaves which are in contact with it, and the withering generally has a tendency to be uneven. The one really serious objection to wire is that many of the leaf tips hang down through the spaces of the net, and in this way much of the finest leaf is apt to get shrivelled and dried before the body of leaves has taken on a sufficient wither.

Chief objection.

Hessian cloth.

The best material at present in use is Hessian cloth of strong open texture, specially made for this purpose. It absorbs a great deal of water when wet leaf is spread upon it; but, far from this being an objection, it is a distinct gain. Some people dislike Hessian on the plea that it gives an objectionable odour to the leaf; this is so only when improperly used. If wet leaf is spread thickly upon cloth, it will generate heat by fermentation and give rise to the odour which is so objectionable. If sensibly and properly used, there is no odour whatever from this cloth, and, if of good quality, it lasts well. Some which has been in

constant use for upwards of ten years is known to be still in very serviceable condition. A serious drawback to the Hessian is that it is liable to rot if very frequently wet. This is frequently the case in leaf sheds which are open and exposed to the weather.

Durability.

Many contrivances have been invented for facilitating the spreading of leaf, or for tilting it off or gathering it up when withered, but thus far no arrangement has been found more satisfactory than a series of fixed racks or frames stretched across the withering room, each about four feet wide and with a slope up towards the back of about twenty degrees, so as to facilitate the leaf being swept off when ready. The first rack of the frame is fixed at about nine inches from the floor and the others at intervals of six or seven inches above it; eight racks in all. If the room is to be operated upon by fans, the racks may be put as close as four inches apart; but this requires great skill on the part of the men who are spreading the leaf, to ensure its being done evenly. If no fans are used, the racks must on no account be closer than six inches, and even seven or eight inches may be better. It must be noted that without special apparatus for circulating the air, it is sheer folly to place the racks too closely; withering is thus hindered instead of facilitated.

Arrangement of racks.

Spread evenly.

The framework of the racks consists of uprights for front and back fixed to the floor at suitable intervals. Round steel wire No. 6 or 8 galvanized is then passed through these supports to the entire length of the frame; one wire at the front and one at the back for each rack or shelf. These wires are to be stretched tight and fixed. The cloth, four feet wide, is then fixed to the wires by lacing with strong twine. Each frame must have enough clear floor space in front to enable the leaf men to spread their leaf

Framework.

properly. Two frames can be placed back to back, but with a space between them, enough for a man to turn in.

Wire stretcher.

A simple and efficient stretcher for wire can be made from a piece of ½ inch gas pipe, 3½ inches long, with several holes drilled through it at each end. A small hole is drilled near the centre. The wire is passed through the upright and its end inserted in the small hole of this stretcher; the stretcher is then turned round, by means of a steel spike winding up the wire until tight, and a nail is inserted in one of the holes to keep it from unwinding. For cool withering houses the old-fashioned changs are still in favour with many succesful planters. The construction of these is detailed in the chapter on Buildings, page 300.

Withering space.

The amount of withering space provided in a factory should be equal to about seven to ten superficial feet for every pound of leaf to be spread each day in the busy season; or, to put it another way, at least twenty superficial feet should be provided for every maund of tea in the total crop. When leaf comes in dry, it requires about seven superficial feet for every pound; when wet it requires ten.

Heaping leaf.

Withering room should be provided sufficient to have all leaf spread at once; it is fatal to quality to keep leaf in heaps on the floor waiting for space to spread it. In the interests of the estate it is incomparably better that some excess accommodation should be provided than that there should be any risk of injuring quality.

Spreading on floor.

If possible, it is well to avoid spreading leaf upon the floor of a withering room; but if it must be done, the floor should be covered with bamboo or similar matting, and if the floor is over a drying room of the factory, all the parts immediately above drying machines or other sources of

heat must have an extra covering of cloth to prevent excessive heat from scorching the leaf.

Treading upon leaf.

After leaf has been spread upon the floor, it is of great importance that no one should be allowed to walk over it. The damage done in this way can easily be verified if any one walks deliberately across a floor spread with leaf; then comes to inspect it two hours afterwards; by that time each footprint will have become distinctly marked in full outline by bruised and discoloured leaf. This is, of course, more marked if the person treading the floor had boots on, but even naked feet will leave their deadly trail of damaged and rotting leaf.

Cool withering.

For hot climates, it is a necessity to have cool withering houses apart from the main factory. There can be no question but that in any circumstances the cooler the withering the better, provided always that the process of withering is actually proceeding all the time.

Very wet weather.

There are occasionally times when a succession of continuously wet days and nights renders withering in open sheds an impossibility, and leaf kept lying about in such circumstances suffers much more than one would readily think.

Putrefaction.

When withering cannot proceed, a certain process of putrefaction takes its place; this is of course checked in the eventual manufacture, but the damage actually done cannot be repaired.

Even upon estates in the hottest climate it is necessary to have some provision for withering in the main factory during a spell of continuously wet weather. The capital expended upon making this extra provision will be well repaid in the improvement of quality during the succeeding two years.

The question of how to treat wet leaf in the first

Wet leaf.

instance is of some importance. Some people prefer to spread it in a cool place for a time, then sweep it up and respread it in a loft where it is subjected to slightly heated air. It is always objectionable to handle leaf at all after it has been once spread, if it can by any means be avoided. If possible, it is better to spread leaf where it is to remain until the process of withering is complete. The chief matter is to be able to regulate the air in the withering rooms, so that the necessary quantity of slightly heated or dried air may be admitted at will.

Dry air is what is wanted, and if some simple process

Dry air.

can be discovered whereby the whole of the air passing through the withering room can be first divested of its moisture, heated air can be discarded with great advantage and a distinct advance made in tea manufacture. As it is at present, with the excessively moisture-laden atmosphere of the rains, some heat must be applied, but the careful tea-maker will see that the heat made use of must never be more than just sufficient for his purpose. Wet leaf must not be unduly forced, but it can bear a higher temperature than dry leaf, because rapid evaporation of moisture from its surface reduces the actual temperature of the leaf itself. 100°F. is not too great a temperature under such circumstances, provided it is a *dry* heat.

In all cases the withering rooms must be kept in

Ventilation.

good state of ventilation. The air must always be kept fresh and sweet, and the more of it passed through the leaf the better.

Light is not essential for withering, but it is necessary for the men to see in order to spread their leaf properly.

Withering fans are of the greatest value, provided

Fans.

they are fixed in the proper place, and used in a sensible manner. It is not

an uncommon thing to find powerful fans fixed in the outer wall of a factory, operating upon quite a small space, and discharging directly into the outer air. It is little wonder that in such circumstances the fans are practically a failure, so far as actual withering is concerned, especially on a hill garden where all the extra heat generated in the factory is required to help withering. When the fans are placed as mentioned above, they simply drive the whole of the heated air out of the factory in a few minutes, and so hinder instead of helping on the wither. In this position they are of course useful for ventilating the factory, but for little else. They can assist the withering, however, if run once an hour for a few minutes only.

Partial use.

In order to obtain the best results from withering fans, each fan should be made to operate upon a large area, and should be so placed that the air from the discharge side may be either sent directly out of the windows into the open air; or may be diverted into another room where it will pass through a series of other racks before eventually passing through open windows at the opposite end. In very wet weather and a cold climate, the fans may be made to *circulate* the air throughout the withering rooms rather than to discharge it outside: at such times a certain proportion of the moisture-laden air will make its way out here and there, to be replaced with new air from the lower storey; and so things will be kept fresh and sweet while withering proceeds.

Night withering.

It has been noted that night withering is best, and the best tea is usually made very early in the morning.

Ventilation.

Before leaf is brought in, all fans should be run for half an hour, in order to thoroughly ventilate the withering rooms. Immediately the leaf is spread, the fans may be set going again, and kept going for the greater part of the night

or perhaps all night, the air admitted to the leaf being directly from the outside, or from the lower floors of the factory, as circumstances may require.

Withering in sun.

No sunshine should be allowed on the leaf. Withering in the sun is fatal to fine quality.

Spreading leaf.

The greatest possible care should be exercised in spreading leaf for withering. Little tufts of leaf or any unevenness must be scrupulously avoided. Naturally, the operatives are fond of spreading the leaf on the racks very thickly, simply to save themselves the trouble of covering a larger area. They think that the application of a little more heat than was intended will måke the wither come all right. Very wet leaf clings in tufts and is very difficult to spread thinly and evenly.

Mixing leaf.

It is a serious mistake to spread leaf thickly; the result must be an uneven wither, some leaf overdone and some underdone. In the same way many tea-men will persist in mixing the leaf from different racks which may be in different stages of preparedness. If one rack has been overdone and the leaf instead of being merely withered has become dry and crisp, they calmly mix with it a lot of leaf in a very green stage, thinking that the mixture will produce a happy medium. The result from such a mixture may indeed be a medium, but it can never be a high class tea. This is just one of the things which no amount of telling will impress upon the mind of an ordinary native overseer, and it is only the strictest supervision which will keep him from lapsing into such ways again and again.

Good wither.

Leaf is ready for rolling when it has become absolutely soft and flaccid, without being in any sense dried up. It should be capable of being twined about or doubled up without breaking the stalk or rib. Properly withered leaf has retained its green colour without any tinge of redness or other dis-

coloration, and without admixture of leaves in an under, or an over-withered state. The best leaf when properly withered has a fragrance like ripe apples.

Under normal conditions, the time required for withering leaf properly is about 18 hours. This has been clearly established by Dr. Mann's various experiments. The two conditions necessary to secure the best results are that the leaf should be chemically and physically ready at the same time. It has been shown that at 18 hours' wither the enzyme has developed to the fullest extent, and that beyond that time the enzyme decreases, so that leaf which is kept over for an inordinate time, by being spread thickly or kept wet, cannot possibly result in tea of high quality. On the other hand, when withering is forced by heat or by withering machine so as to be physically ready (soft and flaccid) at an earlier stage than 18 hours, the enzyme is deficient, and the resulting tea will be to some extent lacking both in flavour and pungency. This only emphasizes the fact, so well known to planters of experience, that, so far as present knowledge goes, there is no method of withering tea which can compare with withering under natural conditions and allowing the atmosphere to have access to each leaf separately during the process. The facts brought to notice also emphasize the unwisdom of keeping wet leaf over from day to day, in withering sheds, waiting for fine weather to have it worked off. If good tea is to be made, the factory must have ample arrangements for withering leaf in all weathers within the necessary time.

Expressor.

Of late years some machines have come into use for expressing surplus juice, when withering facilities are deficient. These are very useful during a spell of continuously wet weather; but it is self-evident that if some of the juice is expressed and thrown away the tea made must be deficient in extractive matter, as compared with tea which has been withered with its juices intact.

Underwithering may be adopted in special circumstances; it results in a stronger liquor on infusion, but the leaf gets rather broken during rolling; some of it comes out flat instead of twisted, and the flavour of the tea suffers to some extent. If the rolling machinery is insufficient for the work to be done, the best policy undoubtedly is to rather underwither the leaf; it may then be rolled in a much shorter time than if fully withered and the result will be very much better than if the machines were kept plodding away to a late hour and the latter portion of the day's leaf overwithered before it can be taken in hand.

Underwithering.

Extra withering tends to develop flavour, and in some circumstances may be advisable; the liquor will, however, be rather weak and pale. The *appearance* of the dried tea may be greatly improved by a little extra withering; the twist will be so as to make it look like wires, and the tips will show up very well, but they tend more to a silvery than to a golden colour. Leaf from heavily pruned tea should be highly withered. It can never make flavoury tea, hence the only thing to be done is to try to give it as good an *appearance* as possible.

Extra withering.

Leaf from heavy pruning.

After leaf has been gathered together in preparation for rolling, it should on no account be left lying about, waiting for the machines to be available. The very act of sweeping it together breaks many of the leaf cells, and the sap being exposed to the action of the atmosphere, a process of fermentation soon sets in, betraying itself by the rapid discolouration of the whole. This change is much more rapid in leaf which has been withered in a heated loft. The remedy for this state of things is simple. The withering overseer must be made to estimate the quantity of leaf required from time to time and to see that the leaf collected is just sufficient and no more.

Storing leaf.

Heated loft.

If leaf is fully withered and no machine ready to roll it, better far to get a little extra withered than sweep it into heaps to get fermented and sour. To keep the leaf on the racks from getting overdone, all windows may be thrown open, and water sprinkled liberally upon the floor, so as to render the atmosphere as moist and cool as possible.

Prevention of overwither.

Withering machines are in use on some estates. They certainly economise space and time, but it is doubtful if they are of any real value. Anything which subjects the leaf to a process of stewing is distinctly objectionable and ruinous to quality, but the time will no doubt come when some process will be invented whereby leaf may, without great expense, be subjected to the action of a current of especially dried cold air, which will preserve the flavour and essential oil, and develop the enzyme, while rapidly extracting the moisture, and adding the necessary oxygen to the leaf.

Withering machines.

Leaf which has been withered in a warm room should have a current of cold air passed through it for five or ten minutes before being swept off the racks for conveyance to the rolling room.

Cooling leaf before rolling.

CHAPTER XVI.

ROLLING.

THE rolling room should be situated in a cool part of the factory, away from the direct rays of the sun, and arranged so that windows and doors may be thrown open to let in cool fresh air from verandahs. or shade of some kind.

Coolness.

If the rolling room forms a part of the main floor of the factory, in common with the drying room, it is very desirable to have the two departments separated by means of partitions of single brick wall or of lath and plaster. Similarly, it is necessary to separate this room from the engine room, or any other place where heat is generated.

Bad odours.

All stores of paint, or any article of a malodorous nature, must be kept quite away from the main factory, because tea is peculiary liable to take up bad smells from its surroundings, especially during manufacture.

Objects of rolling.

The chief object of the process described as *rolling* is to rupture the cells in whch the juice of the leaf is stored ; this has to be done by bruising or macerating the leaf without actually tearing it into shreds.

The cells being burst open, the juice is liberated and flows over the surface of the leaf so that subsequently, when dried, the water only being evaporated, the extractive matter remains on the surface ready to be dissolved at once, on the application of boiling water.

A scarcely less important feature of this process is that the juice must be exposed to the action of the

atmosphere before the next process, that of fermentation, can begin. During the process of rolling, as soon as the juice comes into contact with the oxygen of the atmosphere it becomes more or less oxidised and the chemical changes begin, which transform the crude sap into palatable tea, and at the same time the leaf begins gradually to change colour, so that when rolling is completed, the mass of leaf is soaking wet with its own juice, and its bright green colour has already in it a tinge of copper

Oxidation.

The mere curling of the leaf is incidental to this process. It is not actually necessary, but when leaves are sufficiently tender, they naturally curl up under the pressure applied. If leaf does not curl or roll up in process of rolling, it is evidently too old and tough for the production of good tea, and it eventually betrays its presence in the bulk of the finished article, by flat flaky chips of a reddish colour, instead of being coal black. The technical name of this is "red leaf."

Curling.

Red leaf.

There are several classes of machines in use which do the work of rolling with wonderful efficiency. The saving over hand labour is enormous; one machine can do the work of sixty men, and can do it much more thoroughly. It pays best in the long run to get the best type of machine, and to keep it in thoroughly efficient condition.

Saving of labour.

Care must be taken not to run the rolling machines too fast; they should run at rather under than over the speed indicated by the makers; otherwise there will be a tendency to heating and premature fermentation of the leaf.

Speed of rollers.

In large factories, several of the rollers may have open tops, to ensure light rolling at the first stage; where large quantities of

Open top machines.

leaf are not dealt with, however, the ordinary form of machine with pressure cap can be made to do the light rolling, with a little special care.

Granite tables.

It is advisable to have the rolling table covered with granite slabs or with portland cement, which is often used as a substitute but is not so good owing to its porous nature. No iron should come in contact with leaf during rolling, as it tends to discolour and blacken the infused leaf.

Pressure cap.

The pressure cap should not be unduly heavy, as is very often the case; it should be perforated and ventilated as much as possible. Large holes are preferable to small ones; anything less than three inches gets blocked with leaf and becomes ineffective at the very time when most required. Six-inch holes are not too large.

Cramming.

In order to avoid cramming the machine, it should be started before any leaf is put into it; it can then be fed gradually from the upper floor by means of a shoot until the full quantity has been supplied. Overloading is to be avoided; if an extra quantity is fed into the machine, there may be great heat generated by the excessive weight and friction, but the actual work of rolling will not be done quicker or better.

Weighing leaf.

Weighing the leaf for each machine is not a good plan, because the less handling the leaf gets at this stage the better.

The overseer in charge of the withering department can arrange beforehand, so as to know how many fills of a machine are in each loft, and with a little practice can estimate pretty accurately how much leaf to send down at a time.

Fill of a roller.

A full-sized machine takes four or five maunds of green leaf, the equivalent of one maund of finished tea; hence for every

100 maunds of green leaf weighed in, there will be 20 to 25 fills of a roller. The latest pattern of rolling machine takes 25 per cent. more leaf than the original Rapid. An old Rapid may be made to deal with double quantity of leaf by conversion into an Open Top Machine; the pressure cap being removed, and the hood increased in height by 18 inches. The increased weight of leaf supplies the necessary pressure. Only fine leaf can be dealt with in this way, and it must be fed into the machine slowly. Rolling at first should be quite light, pressure being very gradually brought to bear upon the leaf. If much pressure is brought to bear suddenly, a great deal of the leaf will get torn, especially if the *jat* is delicate and the leaves large and tender. With rough treatment at this stage some of the leaves will become folded instead of rolled, after which they can never be brought into proper form again.

Easing pressure.

The man in charge of the machine has to raise the pressure cap occasionally, in order to prevent balling and heating, and again bring it down as necessary. He has to exercise a good deal of discretion and care, hence the men in charge of rolling machines require to be experienced and reliable. One man can easily work two machines.

Time occupied.

The time occupied in rolling varies with the season and the condition of the leaf brought in. Usually, the first roll can be done in twenty to forty minutes; it is then advisable to take the leaf out and have it aërated and sifted in order to separate as much of the fine as possible from the coarse before the hard rolling is given. The chief reasons for this are that the juice of the coarse leaves, which is expressed during hard rolling, gets mixed to some extent with that of the fine leaves, imparting a coarse flavour to all; also hard rolling tends to darken the golden colour of the fine tips in the finished tea.

Objects of sifting.

Green leaf sifting machines are of various kinds, the most common being in the form of a cylinder, of conical shape, placed horizontally, and turned round slowly. The leaf is fed in at the small end of the cone, and the coarser works its way along to the other end, while the fine leaf drops through the mesh, of which the cone is constructed. The objection to this class of machine is that it is difficult to keep clean. The simpler form of a flat sieve jerked rapidly backwards and forwards, answers the purpose as well as anything. In addition to this there are certain machines with an attachment wherein the leaf is made to pass between the arms of an agitator, whereby the balls are effectually broken up, and at the same time a fan throws a current of cold air on to the leaf, cooling and aërating it during the process of sifting, which is a distinct advantage.

Green leaf sifters.

After sifting, the coarser leaf is put in a roller and rolled hard for half an hour; the pressure cap being occasionally lifted as before, to prevent over-heating. During this roll, the leaf becomes a very wet mass, some of the juice even dripping through the chinks of the table to the receiver below. This may be desirable, provided the quantity of juice expressed is not excessive; the leaf when dropped into the receiver absorbs the juice, so that none is actually lost.

Hard rolling.

When leaf has by any mischance been over withered, so that no juice can be expressed in the rolling machine, a good plan is to add a bucket of water while rolling is proceeding; this moistens the leaf cells and helps to break them, so that the sap may be liberated. Some planters purposely wither highly in order to add water, but it is doubtful whether any special benefit is obtained. High withering improves the flavour of the tea, and tends to the production of

Watering leaf.

silvery tips, but it results also in a loss of some strength in the liquor.

Close twist. It may here be remarked that very closely twisted leaf is not desirable. It looks pretty, but when under infusion it naturally takes a comparatively long time to open out and part with its juice, hence with such leaf a four or five minutes' infusion yields a weak tea.

Third roll. In many factories the leaf is subjected to a third rolling after fermentation and just before being taken to the drying machines. The object of this is to freshen and brighten the colour on the fermented leaf. There is probably some benefit in this at certain times, but it is usually observed that the third rolling makes little or no difference in the colour of the outturn (infused leaf) when the dried tea is afterwards tested, as compared with similar leaf which has had only two rolls. The fresh appearance in the leaf as it comes out of the roller is due to the sap or juice having been again brought all to the surface.

Fine leaf. With ordinary good leaf, two rolls are sufficient. The fine sifted leaf can be rolled a second time like the coarser, provided that the pressure exerted is not very severe.

Hot rolling. The system generally adopted is to do the rolling under conditions as cool as possible. Some planters, however, prefer that the leaf should get heated to some extent during the process, so as to precipitate fermentation. This means a saving of time, and the leaf can be sooner carried through to the drying process, but the work is less under control and the danger of over-fermenting is too great.

Aëration. When rolling is completed, the pressure cap should be raised and the machine allowed to run freely for a few minutes before the leaf is taken out. This is to break up balls and aërate the

mass before it is transferred to the truck by which it is taken to the leaf sifter where it is prepared for the fermenting tables. This second sifting is in some factories discarded on the plea that the leaf should be kept as much as possible in balls, to imitate the balling under the old system of hand rolling. The fermentation comes on more evenly, however, when the leaf has been sifted.

Cleanliness.

Cleanliness is indispensable. At the close of each day's work, all the rolling machines require to be washed with boiling water; no old juice should be allowed to cake on the tables or about the teeth of the pressure caps, etc.

One of the most important of recent improvements in the rolling room is the introduction of steam as a means of cleansing the tables. A piece of flexible steam pressure piping is the best for this purpose and can be attached to half-inch steam pipe from the boiler. With this hose the attendant can thoroughly steam and purify every crevice of the tables, and banish all possibility of the presence of bacteria.

Not only the rollers, but also the leaf-sifting machines, should be thoroughly cleansed in this way; also all trollies and receptacles for holding or carrying the rolled leaf.

CHAPTER XVII.

FERMENTATION.

It is in the fermenting room that most may be expected from the aid of science. Hitherto the work has been guided chiefly by "rule of thumb;" but it may be hoped that soon the investigations of chemists who are especially studying this subject will result in some definite rules of action, whereby the best possible results may be obtained without difficulty or doubt. The most that has been accomplished in this direction hitherto has been to describe the chemical changes which occur during fermentation and to formulate reasons for results which had been previously known. Mr. Bamber discovered that the fermentation of tea leaf is due to the presence of an *enzyme*, or vegetable ferment which is quite distinct from organic fermentation, the latter involving the presence of living organisms, which bring on a certain amount of decomposition and putrefaction. If, however, the process of ordinary fermentation is unduly prolonged, this organic fermentation sets in and the leaf soon becomes sour.

Need of science.

Enzyme.

Fermentation is a purely natural process, by which certain changes take place in the leaf while placed in suitable conditions. No manipulation is required while this is going on, and, so far as is at present known, no addition of any chemical or other substance will facilitate or improve its action.

Fermenting room.

The fermenting room requires to be separate from the other departments of the factory, and yet sufficiently convenient to

receive leaf from the rolling room and deliver it to the drying room, when ready, without undue difficulty.

Coolness. The coolest possible position is necessary. There should also be plenty of space; it is a mistake to suppose that a mere corner of the factory may be crowded up with trays of fermenting leaf, tier upon tier. Ample space, with a fresh sweet atmosphere, is absolutely necessary in order to preserve a pure aroma in the tea. If there is no upper floor, the

Pure atmosphere. roof must be well protected from the heat of the sun. The floor should be of Portland cement, and sloping sufficiently to drain off water which is to be frequently dashed upon it. A good plan is to have a trough along at least one wall, from which water may be taken conveniently at all times.

Abundant water. Water should be laid on to the factory in pipes, with abundance available, especially in hot weather, when a frequent sprinkling on the floor will keep down the temperature wonderfully.

In some factories the windows of fermenting rooms are glazed with ruby glass, or covered with ruby curtains. This looks very interesting, but does not seem to have any effect upon the fermenting leaf.

Fermenting on floor. The most common custom is to place the freshly rolled leaf upon the cement floor, after the latter has been thoroughly washed and drenched, one part of the floor being slightly raised or sloped for the purpose.

This is undoubtedly the coolest place to put it; the only objection being that cement is very porous, and

Stale juice. absorbs more or less juice from the leaf; this juice becomes stale in course of time and no amount of washing can keep the floor absolutely sweet.

Glass beds. The best arrangement known is to have the fermenting beds made with a top of plate glass, which makes a perfect surface for the

purpose, and is not so expensive as at first sight might appear. In some factories glazed tiles are used, and are equally efficient. The tiles or plates of glass require to be bedded and jointed with Portland cement, and when well laid in this way they are not easily broken.

Shelves.

Where space is a consideration, one or two shelves can be erected to receive leaf, besides the beds upon the floor, but the temperature of the shelves will be slightly different from that at floor level, and the fermentation is of necessity somewhat uneven.

Fermenting tables.

Another good arrangement is to have tables made to receive the leaf, about six or eight feet long by four feet wide, standing eighteen inches off the floor, the top covered with sheet zinc or enamelled iron, and a side added, about four inches high all round. This is a clean and very convenient arrangement.

Fermenting in trays.

Sometimes leaf is placed in tiers of trays like a series of almirahs. This is good if the factory is rather small for the work to be done, and all the operations are rather cramped for room. In such circumstances the air is apt to become heavy and impure, and the quality of the tea suffers in consequence.

Fermenting machines.

A development of this almirah arrangement has been made to do duty as a fermenting machine, by closing the tiers of trays with thick cloth along the sides, and fixing a fan at one end of the whole frame. By means of the fan a current of saturated air is passed continuously along the trays. This has the advantage of dealing with a large quantity of leaf within a small space, but the fan uses a good deal of power, and the results are not better than those obtained by the simpler methods. Although plenty of fresh air is undoubtedly necessary, it has been found

in practice that a strong current of air is not satisfactory.

Thickness of spread.

The leaf may be spread one inch to four inches thick, according to the season and the condition of leaf. The first flush is most difficult to ferment satisfactorily, and may be placed a little thickly, so as to encourage slight heat in the mass and thus force the process. Second flush leaf and fine leaf at all times must be spread rather thinly, as it ferments readily and must not have the chance of becoming overdone. At the end of the season it is again necessary to spread rather thickly as the leaf then is tough and the surrounding air may be rather cold.

Cloth covering.

The leaf must be covered while undergoing fermentation, in order to preserve the exposed portion from getting dried and blackened by the air. This is best done by cloths which have just been wrung out of cold water—they should not be dripping wet. Cotton cloth is best; any kind of jute or canvas rots very soon as a result of being so constantly wet. It is well to keep the cloth from direct contact with the leaf, by placing first a wire frame over the tables. If waterproof cloth is used, this need not be done, as the waterproofing prevents the cloth from absorbing juice from the tea.

Steaming cloths.

A most important point is to keep these cloths perfectly clean and sweet. They very soon become stained of course, as tea juice is a very fast dye, but they can be kept quite fresh by rinsing in boiling water once every day. An excellent plan is to have a steam chest in communication with the blow-off cock of the boiler. At the end of the day's work all the cloths are put into this and steamed for a few minutes, the result being a perfect sweetening of the whole. They are then wrung out and hung up to dry until again required.

Time required. The time necessary for fermentation varies with circumstances, so that no absolute rule can be laid down. It may be anything from two to six hours (inclusive of the time occupied in rolling). Sometimes on gardens at a high elevation and in a cold climate very high class tea has been made from a fermentation of thirteen hours. When the climate is hot, the time taken is less, but in any case every effort should be made to keep the fermenting room from getting hotter than 85° F.

Indications. One indication of the progress of fermentation is a gradual change of colour from pale green to a yellowish copper, when the leaf may be considered fully fermented. If left beyond this stage, it gradually becomes a dark green and then black. **Over-fermentation.** Leaf which has been allowed to become over-fermented has sometimes been mistaken for under-fermented, because of its greenish colour, the mistake being discovered on a second examination a little later on. For this reason the different lots of leaf must be kept in proper arrangement and some note kept of the time occupied by each lot.

A good plan is to have a black painted tablet attached to each bed. The hour for each lot to be ready for removal can be chalked upon the tablets by the overseer in charge.

Change of scent. Another indication of ripeness is in the change of scent on the leaf as the fermentation develops. At first there is a raw scent, like that of chopped cabbage, but this gradually changes to a pleasant fruity sort of scent, when the process has reached the best stage, and the expert tea-maker depends upon this scent more than upon either time or colour.

Tips ferment first. Fermentation develops most quickly upon the fine tips or buds, hence the importance of green leaf sifting before fermenting.

No sifter can separate all the fine from the coarse, but a great deal may be done in this way, and the fine so separated can be removed from the fermenting room at a suitably early stage, while the coarser leaf can be treated for a longer time.

Rapid fermentation.

Rapid development is an indication of good quality in the leaf, while similarly slowness of colouring and difficulty in obtaining fermentation indicates poor quality. The first pluckings from heavily pruned tea (if properly grown) usually refuse to develop the proper colour, and as certainly prove to be inferior tea.

Turning over.

Turning over the leaf by hand occasionally while fermentation is going on is a custom which is not so widely followed now as it used to be. It helps to keep the leaf cool, but it somewhat hinders the progress of fermentation and the benefit derived is doubtful.

Watering leaf.

If leaf has been overwithered, a sprinkling of water upon it when spread for fermenting may help to render the colour more bright.

Colour.

A bright greenish coppery colour is what is most desirable, but in some circumstances most difficult to obtain. When it is recognised that any particular day's leaf is incapable of developing a good colour, the best plan is to ferment rather lightly in order to secure pungency in the liquor when nothing better can be attained. Pointless tea is very undesirable. Lightly fermented tea yields a pale pungent rasping liquor.

Pungency.

Fully fermented tea yields a deep coloured, but soft flavoured, liquor

Medium fermentation, if the leaf is good, results in a full brisk sparkling liquor, with flavour and aroma at their best.

Flavour. Dr. Mann has pointed out that the development of flavour during fermentation reaches the maximum at an early stage; and recommends a light fermentation when flavour is the chief consideration. It is somewhat perplexing, however, that this rule does not always hold good in practice. Some of the most flavoury teas on certain estates in Darjeeling have been made with what must be considered a maximum time for fermentation, whilst other estates have produced equally fine results with only about two hours from the time that the leaf entered the rolling machine. The tea-maker must act for the best in his particular circumstances, only the general rule can be laid down that a full-bodied malty liquor can be obtained only after three to four-and-a-half hours' fermentation from the time that the leaf enters the roller. The question of how to produce fine flavour in tea is still shrouded in mystery.

Cleanliness. As in the rolling room, so also in this department, cleanliness is of the utmost importance. The tables or floor where leaf is put must be scrubbed and cleansed systematically.

Fermenting beds should be cleansed and sterilized by a jet of steam being played upon them at least once every day. Zinc linings can be easily cleaned with a little wood ash and ground charcoal with the application of a little hot water and energy.

CHAPTER XVIII.

DRYING.

Chinese method.

FIRING or drying by the old Chinese method has become so nearly obsolete that it is hardly necessary to refer to it here. In some factories for many years there was great reluctance to adopt machinery for this process.

Charcoal fumes.

It was supposed that the direct fumes of charcoal were necessary to the proper development of flavour, and even after machinery had been adopted, it was for years only made partial use of, all the drying being finished on open charcoal fires. Some planters who have given it up still hanker after charcoal, and there may perhaps be some good reason for this feeling.

Saving of labour.

The saving of labour by drying machines is not nearly so great as in rolling. A large machine, however, does the work of 30 or 40 men. There is some saving in fuel, but this is more than made up for by the cost of machinery and the power required to drive the machine, which means a large addition of fuel for the engine boiler. The best class of drying machines are very expensive; but they do the work very efficiently and, when properly worked, with little or no danger of burning the tea. They turn out a brisker tea than by the old system, and much less factory room is required.

Comparison of machines.

There are many kinds of machines in use, and great differences of opinion as to their respective merits; each has its own advantages; and any one of them is an immense improvement on the old laborious and unwholesome

method. The best classes of machines are those which frequently turn over the leaf automatically while it is inside, and which have a substantially constructed stove that seldom requires repairs or renewals. In some machines the hot air is driven through the leaf by a force fan; in others it is drawn through by an exhaust fan.

Position of machines.

Drying machines have sometimes been placed so that the stoking of the stove may be done in a verandah outside the main factory. This has the advantage of cleanliness, but as in this position the air tubes take the air from the outside atmosphere, which during wet weather is saturated with moisture, the efficiency of the machine is thus very greatly crippled. Such air, when heated, of course becomes capable of taking up more moisture, but cannot be anything like so useful as the comparatively dry air within the factory itself. Dry air is of very great importance, both as to quality and quantity of work done.

Draughts.

Each machine has to be placed so that no draught from a door or window will affect the air tubes of one side more than those of the other. An open door directly opposite one set of tubes can make a difference of twenty degrees of temperature on one side of the machine from the other, because the fan naturally draws its air from the readiest or easiest source, and the heat carried through is proportionately irregular. Every machine requires a thermometer at both sides, in order to indicate at all times whether heat is being applied evenly.

Objects of drying.

The first object of the drying machine is to arrest fermentation, and then to slowly dessicate the leaf, in such a way as to extract all the moisture without dissipating the essential oil or the other aromatic properties of the tea

Essential oil. One of the most important points to be noted in connection with this process is that the essential oil, which contains the flavour, is exceedingly evanescent, and can very readily be driven off, or greatly reduced by wrong methods of procedure. A very high temperature is fatal to it; so also is an exceedingly strong blast or draught in machines which are worked at what may be called high pressure.

Temperature. The general practice is to put leaf through the machine twice in order to get it thoroughly dry; the first time at rather a high temperature 230° to 280°, and the second time at about 200°. This necessitates having two sets of machines for the work. It will be noted that the temperature referred to is that of the air as it enters the drying chamber from the stove: this is usually greatly reduced before it gets through all the leaf and finally escapes into the atmosphere.

The leaf can stand a high temperature when first going through the machine, because it is so sodden with moisture that the rapid evaporation of this keeps down the heat on the fibre of the leaf itself.

Actual experiments with a Paragon Drying machine have shown that when loaded with leaf and the temperature registered by the thermometers at the entrance was 260°F., the actual temperature at the bottom tray of machine was 240°; second tray 236°; fourth tray 220°; and top tray 100°.

It is thus seen that when the drying air has to pass through several trays of leaf in succession, it rapidly loses heat in proportion to the amounts of moisture which it takes up and when the actual temperature is high, the air takes with it a considerable portion of essential oil; this oil is, however, to a large extent given up again as the air passes through the succeeding trays of tea; so that with anything like the temperature here

recommended for working an automatic drying machine there is after all very little loss of essential oil.

Spread thinly.

It is important that the leaf should be spread evenly and not too thickly. When leaf is in a dense mass, the application of heat tends to steam and stew it, because the moisture cannot get away. For the same reason it is no saving of time to overload the machine, in which case the work is delayed rather than accelerated. For square tray machines it is well to have a box with which to measure the quantity of leaf to be placed upon each tray.

Turning tea.

When turning tea by hand, it must not be done in a slovenly manner, leaving the small fine tea at the bottom of the tray untouched; the fine tea especially should be well turned over and mixed with the rest.

Second firing.

The second firing may be done at 200° with safety; this is a lower temperature than that of boiling water, so that there is no great danger of scorching the tea; hence the operation may be done as slowly as circumstances require.

In some circumstances it is best to complete the firing of the tea at one go through the machine. This is the view strongly held by some of the most successful tea-makers of Darjeeling. On the other hand, Dr. Mann recommends that the tea should be rapidly passed through several machines in succession. If done in only one go the greatest care has to be exercised, because the leaf must be spread thinly, the speed slow, and the temperature fairly high. In any case, tea should not on any account be kept lying about in a partially dried state, waiting for machine accommodation.

Stoking.

The all-important work in connection with a drying machine is in regulating the temperature and stoking so as to keep it as even as possible. The most reliable man available should be put to this work. If a stoker fills the furnace to its utmost

capacity with fresh fuel, the natural result is a great rise in temperature, and in order to keep the heat in the drying chamber down at the necessary figure, the cold air inlets with which it is provided have to be opened to their fullest extent, which means a serious waste of heat and of fuel. The sequel to this is a turn of the reverse, for by the time that the furnace gets its new supply of fuel, the fire has sunk too low, and before a new spurt can be got up, the temperature in the drying chamber has fallen seriously below the standard figure, resulting in some of the tea coming out soft. The remedy for all this is to have a suitable man in charge, and have him well looked after.

The furnace should be supplied with fuel very frequently and in small quantities at a time as required. The temperature should be regulated at the furnace door much more than is commonly the case. The cold air inlets are to be used as little as possible, and considered more as emergency arrangements.

Cold air inlets.

When a machine is standing waiting for a new supply of leaf, the furnace should be damped, and the doors of the drying chamber thrown wide open. Any tea lying about must be swept up to avoid its being scorched meanwhile and so injure the flavour of the new lot when it comes.

Machine waiting.

Working at a very high temperature may occasionally be necessary, so as to get through as much work as possible in time of stress; but it is dangerous and almost sure to injure flavour, by driving off some of the essential oil of the tea. Very powerful fans have the same tendency, and if the best results are to be obtained in regard to quality, a machine must not be run at what may be termed "high pressure."

High temperature.

Powerful fans.

The fan of a drying machine should not be run at a greater speed than that indicated by the maker. In

some instances it might be run at a lower speed with advantage.

Flavour. No flavour can be imparted to tea during the process of firing, except a flavour of roasted fibre, which is to be guarded against. The way to preserve and develop the natural flavour in the leaf is by careful firing in the finishing stages, and firing so that all the moisture is driven off as thoroughly as possible.

Test of crisp drying. When tea leaves the machine it should be perfectly crisp. This may be tested by taking a few of the coarsest leaves and rubbing them to a powder between the palms of the hands. If there is any soft residuum, the drying has not been complete.

Even in the best regulated factories it occasionally occurs in the busy season that drying has to go on during part of the night.

Night work. Night is the time when the operatives are most likely to scamp their work, and when they require the closest supervision. They should, of course, be paid extra and paid well for this trying work, but it is much better, whenever possible, to avoid it altogether. It is incomparably better to start work very early in the morning, and roll leaf by lamp light, than to leave the very important work of drying to go on into all the hours of the night.

CHAPTER XIX.

SIFTING AND SORTING.

Fluff.

DURING the process of sifting tea, a great deal of light fluffy matter becomes detached and to some extent clouds the atmosphere, gradually settling on every part of the room. For this reason the sifting room must be separate from the other departments, especially from any part where machinery is going, as the fluff would more or less clog the journals and other wearing parts. This fluff is the thick hairy down which may be observed on the buds and on the underside of fresh young leaves.

Orange colour.

It is this fluff on the young leaves and buds which during manufacture assumes the orange colour which gives the name to orange pekoe or flowery orange pekoe. The slightest friction detaches it from the leaf; hence the necessity for great care in manipulating tea after it has become crisp in the process of drying. This fluff is sometimes described as "bloom," because it plays so important a part in tea with a good appearance; apart from this it is not of much value, as upon infusion it does not give much depth of liquor, nor does it improve the flavour or aroma in the cup.

Caffeine.

Although tea fluff is so light in weight as to rise readily in a cloud during sifting operations, yet if it is carefully swept up from the floor daily, the weight reaches a very respectable total by the end of the season: so that for every thousand maunds of tea manufactured there may be as much as twenty maunds of fluff. This fluff is saleable in Calcutta at about five to ten rupees per maund, and is used by chemists for the manufacture of caffeine.

Sifting machines. There are several kinds of sifting machines in use, the chief distinction being those which revolve and those which oscillate. In all cases the tea is made to pass over wire mesh which is agitated in such a way as to encourage as much as possible of the tea to pass through the mesh.

Horizontal sieve. Either class of machine may be very effective when carefully worked. There is perhaps nothing better than the plain open horizontal sieve which was invented long ago, and with which the tea can be almost perfectly sifted, while being at the same time completely under control. The great object is to separate the different classes required, with completeness, from the bulk or mass of tea with the minimum of friction and consequent dust.

Sorting. The process of sorting does not mean in any sense the classifying of teas, but merely the sorting out of any unsuitable hard leaf which may have inadvertently got into the tea, and which, instead of taking on the usual twist, has become flat red leaf; also sorting out long stalks and all foreign matter, such as chips broken from leaf baskets or mats during the various stages from the plucking of green shoots to the final drying process. Sorting is chiefly done by hand sometimes with a neat little pair of tweezers made of bamboo.

Stalk. There is a strong trade objection to the presence of stalk in the teas. No doubt many consumers look upon stalk as an impurity, although there is behind this attitude more prejudice than knowledge. When stalks are picked out from the tea and infused by themselves the resulting liquor is found to be strong and coloury, with a nutty flavour which is not unpleasant. The appearance of stalk in the tea is against it, especially when in process of rolling the bark has got rubbed off, and the stalk looks

like a dry stick. It must be prevented and eliminated as far as possible.

There are several causes which tend to the production of stalk. If bushes are kept very small by severe pruning, and yet otherwise so treated as to continue in robust health, they may produce a large crop of tea; but it must of necessity be tea consisting of large leaves and long stalks. The same thing results when the bushes, although large, are opened out very much in pruning, with a view to the production of vigorous growth ; the vigorous growth must of necessity in such case mean long stalks. Healthy bushes, with as large a plucking surface as practicable will produce a minimum of stalk.

Causes of stalk.

Another cause of stalk is excessive shade over the tea bushes. The effect of shade under a dense tree is to encourage only spasmodic growth in the tea. For a great deal of the time the tea does not grow at all, while on bushes away from the shade the growth may be vigorous. At intervals, however, the shaded tea makes a spurt, a few shoots here and there suddenly running up long, producing almost more stalk than anything else. It seems to be a natural effort of the bush to throw out a few arms as long as possible, with a view to getting out into the sunlight. For this reason, all shade trees and shrubs, such as Siris, Medeloa, etc., should be kept rigorously under control by frequent lopping, and all annual crops for green manuring kept as much as possible from climbing up on the bushes during the period of growth.

Amongst the causes of stalk which are beyond the control of the planter are the various peculiarities of weather and seasons. At some seasons there is a tendency to stalky growth more or less on all estates. A spell of cloudy weather, lasting for several weeks, in mid season, is always certain to result in an abnormal growth of stalk.

Sometimes the statement is made that much coarser leaf is plucked in all tea factories now than used to be the case twenty or thirty years ago. The sorting room of most modern factories offers a complete refutation of this statement, for whereas a garden making annually say one thousand maunds of tea used to require a daily staff of 15 or 20 women to sort out red leaf, etc., now two girls daily are more than enough for the work, which consists simply in taking out chips of basket or mat, for the plucking is so fine that red leaf is seldom seen, and not half a maund of it accumulates from a thousand maunds of tea. There are still some estates where quantity is the aim, and rough teas are still turned out, but on the majority of gardens in the best districts the tendency has been more and more to fine plucking, such as was not dreamed of thirty years ago.

Comparison of quality.

Red leaf.

Young women are best for the work of the sorting room. People with infants or children should be rigidly excluded.

Sorters.

Usually the tea is sorted twice—once before sifting and once after; if, however, the tea is rather rough, it is a good plan to pass it first over a No. 6 sieve (six spaces to the inch) which separates the coarser from the fine, and so saves the latter from the excessive handling which under such circumstances the coarse must get during sorting.

It is well to have as few classes as possible, and to keep the crop produced by any one estate as uniform in character month by month as the circumstances permit. Large buyers of tea like to know what sort of article to expect from any particular mark, and, if they can depend upon it, are more likely to give such a mark their attention.

Uniform teas.

For gardens which produce fine teas, only five classes are necessary, *viz.*, *Broken Orange Pekoe*, *Orange Pekoe*, *Pekoe*, *Pekoe*

Classes of tea.

Souchong, and *Pekoe Fannings* (or *Fine Broken Tea*). The first consists of terminal buds and embryo buds with portions of the finest leaf, which have got broken off during manufacture; the second consists of some terminal buds and the finest leaves; the third and fourth consist of the coarser leaves, while the fifth consists of the fine powdery fragments broken off from all the others and includes also flaky scraps of the leaves, sometimes called "fannings." The liquor of Pekoe dust is often very good, but this tea is not in favour because of its minuteness and its awkwardness in the teapot; hence, the price paid for it is less than the others and the tea-maker has to manage his work so as to make as little of this as possible. It is a good plan to mix fannings and dust together, sending the whole as fannings. Some estates get a higher price for such fannings than for Pekoe Souchong or Pekoe

Fannings.

Fannings which are rather large in size should be rubbed through a No. 8 hand sieve in order to make the whole uniform.

A very common custom is to put the bulk through a cutting machine before sifting at all. This is a suitable plan for teas of medium quality; and it results in a high proportion of the finer grades, besides making the teas have a more even appearance.

Cutting bulk.

The first sieve on which the tea is placed is a No. 13 (or for Assam tea, No. 12); this separates the Broken Orange Pekoe. The rest of the bulk then passes on to Nos. 12 and 10, which take out the Orange Pekoe and Pekoe. The residuum which passes over this sieve and out of the machine, is the Pekoe Souchong, and it is carried on to a cutting machine where it is chopped to a certain size and so equalized.

Nos. of sieves.

Cutting machine.

Very little whole leaf Pekoe Souchong now goes into market. Buyers prefer to have this cut small, as such

tea infuses much better than whole leaf tea, and also lends itself better for purposes of blending.

This grade of tea should be chopped quite small and classed as Broken Pekoe Souchong.

Gardens producing less than 1,000 maunds should not have more than four classes of tea.

The best class of cutting machines are those which chop the leaves into equal length by an actual cutting edge. Those which force the tea through a sieve by a sort of grinding motion are to be avoided, as they make too much dust and the whole surface of the tea is subjected to so much friction that it assumes a dull greyish colour instead of the glossy black which is so much desired.

Grey tea.

The Pekoe Souchong, after being cut, may be passed over the No. 10 sieve a second time, in order to take out any Pekoe which may have escaped the first sifting.

Second sifting.

The dust can be taken out of the B. O. P. by a No. 24 sieve attached to the machine for this purpose.

The fannings have now to be taken out of all the grades of tea. This cannot well be done by any process of sifting, and if the work is done by hand it is too costly in labour.

Fannings.

Some estates have for many years used for this purpose the machines which farmers have for winnowing their grain, and these do the fanning of teas quite efficiently. There are several well-known makes of these machines, all constructed on very much the same principle. Corbett, of Shrewsbury, and Baker, of Wisbech, England, make good machines. The one drawback to these machines is that they are made too small a size, and for hand power principally. They can be adapted for power driving, however, and with care can be made to last a good many years.

There are one or two Fanning Machines in use which have been specially designed for tea and are really a copy

of the farmer's winnower, and adapted for power driving. They are, of course, a good deal dearer than the machines above mentioned ; but it is doubtful whether they do the work more efficiently.

Fluff. During the process of sifting a great deal of fluff becomes detached from the tea leaves by friction. Some of this settles into the Tea Dust, and has to be winnowed out, because the buyers of Tea Dust generally object to its presence in any quantity. This can be fanned out by the machine, and mixed with the fluff which is swept from the floor of the sifting room. This with all tea sweepings can be sold to chemists for manufacture into caffeine. The price given for sweepings in Calcutta varies from five to ten rupees per maund packed in bags.

Coarser teas. When the plucking has not been strictly confined to the bud and the leaves, and teas are not of the finest quality, the assortment must be a little different, and the sieves must be a little coarser. If the factory is turning out more than three thousand maunds of tea annually, another class or even two classes may be added, *viz.*, *Pekoe* No. 2 and *Broken Pekoe Souchong ;* but if the total crop is small, the number of classes is better not to be increased, and if a coarser assortment of teas is to be made they would be named *Broken Pekoe, Pekoe Pekoe Souchong*, and *Fannings* respectively. A somewhat coarser set of sieves should also be substituted for those named above, say Nos. 11 and 9 instead of 12 and 10.

It not infrequently happens that when an invoice of tea goes into market every grade fetches almost exactly the same price, and the planter is tempted to think that the sifting and classifying of the teas has been a needless operation. Correct sifting is necessary, however, as the dealer requires always a tea which will suit for his blend, and in the case of teas destined for the

Russian market especially the finer grades must be even in size with clean whole leaf.

Overclassing.

If is of no use attempting to overclass a tea. All teas are sold on the merits of the samples drawn from them, and a high-sounding name applied to a coarse tea, is more likely to engender prejudice against it than in its favour.

CHAPTER XX.

PACKING.

AFTER manufacture has been completed no tea should be kept lying loosely in boxes or other open receptacles. Tea attracts and absorbs moisture from the atmosphere to a perfectly marvellous extent. Any considerable quantity of moisture soon leads to softness and mildew, which means decomposition.

Loose tea.

When once a tea gets slightly soft, the process of decomposition has begun, and some of its best properties are lost. Refiring will check this, but it can never restore to the tea any of its lost constituents, or the perfection of flavour and aroma which it possessed before.

Softness and mildew.

If teas are packed daily as manufactured, there is no danger of harm by this means, provided that final firing and packing follow close upon manufacture.

In small factories, it is always advisable to store the tea in bins until there is sufficient of each class to form a break. Some planters of experience are strongly of opinion that tea is improved by being stored in bins for some time before packing, and advise that in all cases it should be stored in this way for a week or more. Perhaps this idea has its origin in the fact that all tea becomes more mellow in flavour and aroma after a time, and it decidedly improves if kept thus from the influence of the atmosphere. Tea is said to be unwholesome until at least three months old; certainly its flavour is not at its best until then. And if properly sealed it may be kept without the slightest deterioration for years.

Bins.

Final firing.

Before being packed, it is necessary that each l(of tea should receive a final firing, : order that all trace of moisture shoul be driven off. Many large factories have special machin(in the packing room for this purpose. Some planters a: of opinion that only machines which work by natur: draught are suitable for final firing, but the best class (automatic machines can be made to do the work full as well as any natural draught machine, and very muc more expeditiously.

Fan Shutters.

During the final firing, the fans of drying machin(must be partially and sometimes nearl completely shut off, by means of th shutters provided for the purpose. These must b regulated according to circumstances. A strong draugh is undesirable in final firing, lest the aromatic propertie of the tea might be carried off.

Temperature.

A temperature of 220° to 280° may be maintained a the entrance of the drying chamber a circumstances may require. Whateve figure is fixed upon should be carefully adhered to, i order to ensure a uniform tea. The feeding also must b even and of uniform quantity throughout.

A wiry tea like Orange Pekoe requires a lowe temperature than tea of a larger leaf like Pekoe c Pekoe Souchong.

A very small tea like Broken Pekoe or Peko Fannings, or Pekoe Dust, requires a high temperature because the tea lies closely together and the hot ai cannot readily pass through it.

Test of firing.

On leaving the drying machine, the tea should be s hot that it cannot be held in the palı of the hand ; yet there should not b the slightest taint or scent of scorching. The assistan in charge of this work should infuse a little of the te from time to time to test whether there is any trace o overfiring or singeing. This can be at once detected in th

cup, either by the scorchy aroma of the liquor, or by the colour of the infused leaf. By slightly overfiring, the leaf turns out a rather dark colour instead of being bright coppery. After decidedly high firing, some of the leaves being singed will retain their curl, or only partially open out on the application of boiling water. Burnt leaf comes out of the cup quite black and breaks into powder on being touched.

Cooling.

After final firing, it is desirable to cool the tea a little before packing it in the chest. The turning over during bulking secures this, and the tea can be sealed up warm but not too hot.

Bulking.

The factory is the natural and proper place for bulking to be done. If reasonable care is exercised, it can be done both cheaper and better than in dock warehouses; and the chests being properly sealed up, should be allowed to remain so until the tea is to be put into actual consumption. For some reason, there is a general opposition on the part of London firms to factory bulked teas, and it is for the planter to bulk his teas with such care and thoroughness that there can be no room for reasonable objection. Whether the teas are to be rebulked in London or not they should always be thoroughly bulked at the factory. This may be done partly before final firing, by arranging that a basketful of the first and of the last manufactured tea should be fed into the machine alternately. The real bulking, however, must be done after firing, because in case of any irregularity in feeding or in temperature during the process some portion of the tea may come out more or less fired than the rest.

Process of bulking.

A thick canvas sheet is spread upon the floor of the packing room. Round this are ranged in a circle the baskets of tea as they come from the drying machine in regular rotation. After the whole of the tea comprising the break has been so

arranged, the first basket of tea is tilted upon the centre of the sheet, then the last one, and so on alternately, each lot being tilted over the centre of the heap. After the whole has been heaped together, a new heap is begun by shovelling from the old heap with wooden spades, again taking care that the tea is all tilted over the centre, when the bulking may be considered complete.

Bulking machines.

Bulking machines have been invented, but are probably as yet too elaborate and costly for individual factories to adopt.

Packing machines.

There are several styles of packing machines in use. All are worked on pretty much the same principle. The chest is held in a clamp on the machine, and is subjected to a very rapid vibratory motion as the tea is poured into it.

All the finer teas should be packed by machine, this being the most effective manner, and there is thus no possibility of any portion of the tea being ground into dust. For packing the coarser classes of teas, none of the machines at present in use are very successful ; there is a tendency for such teas to get shaken up instead of down, especially if the tea is light or flaky in character.

Hand packing.

These teas must be packed by hand, a little being put in at a time and gently shaken or pressed down. If pressure has to be applied, a clean cloth must first be spread over the tea in the chest.

Size of breaks.

For common class teas, a break may consist of from 50 to 100 chests or even more, but with teas of fine quality not more than 25 to 40 of one class should go. In any case the large dealers are always fond of large breaks, but the producer must consider his own interest, and not pack his teas in such large lots as to reduce the number of possible purchasers and so restrict competition. Very small breaks do not

Small breaks.

receive much attention ; hence, small gardens should wait until enough can

be collected to form a suitable break before despatching, or reduce the number of classes in assortment.

Half chests.

Half chests are not desirable, unless the tea is of very high quality. These packages are proportionately much more expensive in the first instance: they are much heavier for the quantity carried, and hence make transport of the tea more costly, and the allowance for draft is taken out of each half chest just the same as from full chests; so that in every way it is an expensive mode of packing.

Sampling allowance.

About two ounces should be put into each chest in excess of the invoice weight to allow for sampling.

Slack packing.

The weight of tea put into each chest should be uniform, in any one break. As much as possible, however, should be put in, because if the tea is packed loosely, it will suffer very much from friction during transit; besides which, slack packing is expensive; every extra and unnecessary chest used for a break of tea means extra cost; and the ocean steamers charge not by weight, but by measurement hence a chest containing 100 lbs. is carried for the same price as one of the same size containing only 95 lbs.

Timber for chests.

The boards used in making the chests should be thoroughly seasoned. This is very important for several reasons. Unseasoned wood is heavy, the tare alters during transit; it shrinks and warps and often splits. Certain kinds of unseasoned wood have been repeatedly found to generate a certain kind of acid during the voyage to England, resulting in the lead lining being corroded and serious damage done to the tea.

Damaged tea.

Unsuitable timber.

Chests should always be made of substantial timber; *simal*, for instance, is a very doubtful material, especially if the tree from which it is cut has not become quite mature. Even if

the chest holds together until it reaches the London market, the finishing touch may be put upon it during manipulation in the bonded warehouse; and if a grocer finds that the tea which he has bought is encased in a shell which is literally crumbling into dust, exposing the contents at various points to the influence of the weather, he is not likely to purchase that garden mark again.

Chests should be made carefully, either dovetailed, or with corner pieces. The latter form is most in favour because of its greater strength, and not requiring to be hooped.

Equalizing tares.

When preparing the empty chests for packing, the tares or weight of the packages must be carefully equalized. This can be done by selecting for each break or class the necessary number of chests of a uniform weight: thus 18 lb. chests may be used for Pekoe Souchong, 20 lb. chests for Broken Pekoe, and 22 lb. ones for Pekoe. Such a selection is assisted by using lighter or heavier lids for certain chests.

Loose scraps.

No scraps of lead or other material should on any account be inserted in order to equalize tares. The trade has a strong objection to such expedients, because grocers are naturally apt to think that the scraps have been placed there for some fraudulent purpose.

Effect of moisture.

There is no certainty that the weight of the packages will be the same on their arrival in London as when they left the factory, because most kinds of timber are exceedingly susceptible of moisture, and it has been ascertained by actual experiment that an empty chest from the factory placed in an open shed during wet weather, but sheltered absolutely from rain, absorbed fully one pound of moisture from the atmosphere within three days. It is impossible therefore to be sure of the tares being the same on arrival at destination as at the factory; but

if equal at time of leaving, they are likely to remain equal, because all the chests of a break will probably be subjected to the same conditions *en route*. Metal chests have the initial disadvantage of being expensive, and have to contend with a prejudice against them on the part of grocers. This prejudice was originated probably by the earlier consignments of metal chests having been badly constructed, and not properly sealed from the influence of the atmosphere, which resulted in rapid deterioration of the tea.

Patent chests.

Patent chests of various kinds are in use, and are, of course, more expensive than chests made from local timber: but in situations where there is no timber available they are competing successfully against chests imported from Norway and Japan. The kinds which have proved most satisfactory are the "Imperial" and the "Venesta." The latter is made of the famous three ply boards which are rapidly coming into use for all sorts of purposes. They are expensive but remarkably good packages. Whatever class of chest is used, it is important that it should be capable of being hermetically sealed, which is indispensable to the proper preservation of tea.

Soldering air-tight.

The chests should be carefully soldered after packing and made perfectly air-tight; the nailing down being carefully done and no nails driven in such a way as to pierce the lead lining.

Marks.

Each chest should be clearly stencilled with the garden mark and the progressive number—nothing more.

CHAPTER XXI.

SOME INDICATIONS OF QUALITY.

IT may be accepted as a general rule that slowness of growth tends to quality, and that a large crop per acre is incompatible with fine tea.

A small crop does not necessarily mean fine teas, as some people too readily assume. Many estates both on the hills and the plains yield a very small quantity of tea per acre, and yet remain near the bottom of the list in regard to prices.

Rapidity of growth.

Anything which promotes slowness of growth, without in any way diminishing the root power of the bush, will inevitably improve the quality of teas produced. Whatever promotes very rapid growth has the contrary effect. This is always observable during a sudden rush of leaf in consequence of especially favourable weather, and it is probably the chief explanation why the districts which produce large crops very seldom get fine prices, and even on those rare occasions the good quality is due to special causes, which to some extent, retard the growth for a time, as well as to the alertness of the manager who takes full advantage of the special circumstances. In the same way it is invariably the case that, after heavy pruning, if the bushes are allowed to get a proper start, growth will be exceedingly rapid, but it is impossible to make fine tea from the leaf produced. On the other hand, if, after heavy pruning, a system of close plucking is adopted, some very fine teas may be made, but this is due not to any cleverness or care in manufacture, it is simply because the bushes have been checked by the closeness of the

Heavy pruning.

plucking and the growth stunted. In this case the roots are putting forth a desperate effort, and the bushes are endeavouring in vain to cover themselves with foliage to replace that which was cut away. When this special effort is expended, the bush gradually lapses into a sickly condition. The observation of these results has led some planters to adopt the mistaken idea that in order to obtain fine teas the bushes must be brought into a somewhat sickly state. No greater mistake could be made, and it may be remarked here again that it is much easier to destroy health than to regain it.

Sickly bushes.

Quality within leaf.

In order to obtain fine tea, the quality must be in the leaf itself when brought to the factory; otherwise, no skill or care in manufacture can possiby produce high class teas out of coarse leaf or even from small leaf if it has not in its cells a proper supply of the necessary juices in a fresh and untainted state. It must also be admitted that the finest leaf ever produced may easily be turned into very bad tea by a wrong system or by absence of system in the manufacture.

Destruction of quality.

Elaboration of sap.

Wet weather.

On examining a fresh young leaf which has been plucked, if it presents an appearance of very prominent ribs, and its colour is a very dark green, there is no hope of good tea from it. The leaf cells may be large and full, but the sap contained is watery; the leaf has been formed so rapidly that there has not been sufficient time for the elaboration of sap under the action of sun and air, etc., or it may be that the weather has been so continuously wet, with an absence of sunshine, that the fluid absorbed by the roots from the ground was extremely dilute, containing little else besides water, and the roots were consequently unable to send full nourishment up to the growing leaves.

Poor quality also results from leaf which, when taken between the forefinger and thumb, is found to be as thin as a newspaper. In this case the leaf cells are not well developed, and are practically empty of juice, the cause perhaps being a want of vigour in the bush, resulting from attacks of red spider or other blight, or from want of cultivation, etc.

Thin leaf.

Anything which causes general debility will eventually tend to the production of weak tea.

General debility.

In the earlier stages of the season after the first flush, it is necessary to allow a shoot to develop pretty fully before plucking, so as to give time for the proper elaboration of sap. At this stage it will be found that the best tea can be made when the shoot has developed four or five leaves so that in plucking the bud and two leaves, the plucker has to leave one or two excess leaves behind. There is a stage beyond which a flush should on no account be allowed to run; when leaf is too old, the sap, which perhaps two days previously would have been available as essence of tea, has now become digested by the bush, and is, to some extent, transformed into fibre, which will never yield good liquor.

Early season.

Old leaf.

Towards the end of the season the best tea is made from the youngest shoots. Growth is then slow, and so much new wood has been left on the bushes in successive pluckings that the sap has a long way to travel, and thus becomes thoroughly elaborated before reaching the tips of the shoots.

End of season.

Good quality leaf, when plucked, is usually of a light green or yellowish colour and thick texture, with a more or less stunted appearance. The fine large succulent leaves with long stalk and silky touch, such as come the first year from heavily pruned tea, are very pretty, but are not good.

Appearance of leaf.

During manufacture there are certain indications by which the expert tea-maker knows whether he has the right quality of material to work with. The leaf spread for withering will have a bright yellowish appearance, and when properly withered fills the withering loft with a faint scent like the aroma of ripe apples. The scent emitted is quite strong when a handful of the leaf is taken and pressed together.

Indications in factory.

Colour and aroma.

During rolling, the juice is of course expressed from the cells of the leaf, and the whole becomes a wet mass. This juice should be thick and sticky ; if it is thin and watery, the tea will not be good. During fermentation, the colour will come on readily on good leaf and will be bright from the first, whereas with leaf of inferior character the colour will come slowly and the tendency will be to dry up or become blackish green rather than the bright coppery colour desired.

Appearance of juice.

Colour of fermented leaf.

In testing tea there are certain indications of quality, apart from the actual tasting of liquor, which to a very large extent guide the tea-maker or the tea-buyer.

Indications in testing.

The liquor of a good tea has quite a bright sparkling appearance immediately it is poured out.

If of the Assam variety, it will rapidly become milky as it cools down, until it gets quite thick and looks as if a quantity of rich cream had been stirred into it. This is usually the case with fine tea of this class, although not invariably so. With the China variety there is seldom any creaming, although the tea may be superior to the other in both richness and flavour, hence creaming cannot be taken as an invariable test of a good tea ; but when present, it may be assumed that the tea is at least strong and rich in quality. It is no indication of flavour.

Creaming.

Colour of outturn.

Bright infused leaf is almost invariably a characteristic of good tea. Something like gold, or like a greenish coppery colour is what is most desirable. Colour is not an absolute guide, however, because sometimes leaf, which has been spoilt in the field by fermenting in the baskets, may afterwards show up splendid colour on infusion, although the liquor produced is rotten and detestable. On the other hand, it has occasionally been found that tea with a remarkably fine flavour gives a dull dark infused leaf; this is a rare occurrence, however, and does not disprove the general rule.

Banking.

Some buyers, who are not quite sure of their palate rely to some extent on the "banking" qualities of infused leaf. After the liquor has been well drained off, good banking leaf will still retain a considerable quantity; so that when pressed together like a sponge quite a lot of liquor may still be got from it. This proves that the leaf is of thick well-developed texture with fully-formed cells, in which liquor has been retained.

Tea tasting.

The ultimate test of tea is of course in the tasting; but very few people possess a palate of sufficient delicacy and steadiness to be relied upon. Probably not one man in five hundred is capable of becoming a really good and reliable taster. Many men can at certain times discriminate between teas with remarkable precision, but at other times are as far out as any one. A tea planter cannot be expected to be an expert taster, although he may come very near that description, and in any case it is part of his duty to taste and test his teas in every way possible, and to get all available assistance from professional tea tasters, in order to ensure that the daily manufacture is up to the proper standard, and that he is getting the best results possible in the circumstances.

CHAPTER XXII.

GREEN TEA.

THE chief feature in the manufacture of green tea, as distinguished from black, is that the green does not undergo any process of fermentation, while the slow operation of natural withering or wilting is replaced by the more rapid one of steaming.

Greenness retained.

Immediately the leaf is brought in from the field, its manipulation may be undertaken. When leaf has to be kept overnight, it must be kept in a perfectly cool and moist condition, so that its freshness and green colour may be retained. In hot weather it is necessary to add a sprinkling of water.

Panning.

The first process, according to the old Chinese method, is that of panning or steaming, the object being to render the fibre of the leaf soft enough to stand rolling or bruising without being torn to fragments.

Stove.

For hand manufacture, the pan is a large cast-iron vessel, shaped like a wash-basin, which is built into a brick stove in such a manner as to resemble a basin let into a wash-hand stand. The front of the stove is about three feet high, and the back a foot higher, so that the pan is on a slant, and the operator can stand in front and work at it conveniently. The stove is fired at the side or the back, so that heat is applied to the bottom of the pan, while the smoke or charcoal fumes are carried away by means of a chimney.

When the pan is roasting hot (about 250°) a small quantity of leaf is thrown into it, and is kept tossed about by hand, so that no portion is allowed to rest upon the

hot iron long enough to get singed. Under the influence of this heat, the moisture in the leaf soon begins to escape in the form of steam which rapidly causes the leaf itself to wilt or wither.

Steaming.

As soon as the leaf has become soft enough to stand a light rolling, it is whisked out of the pan and is rolled gently by hand on a bamboo mat while steaming hot.

Rolling.

After a few minutes, it is again thrown into the pan to undergo a further steaming, being steamed and rolled alternately until the leaf begins to get slightly crisp.

While manipulating the leaf in the pan the operator requires to have a pad of cloth in one hand, with which to rub off any leaf which might stick to the bottom.

Pad.

When very wet leaf is treated, care must be taken that not too much is introduced to the pan at one time, because the excessive amount of steam emitted is apt to cause the leaf to ferment and become discoloured.

Wet leaf.

As soon as the leaf begins to get dry and slightly crisp, it is taken to the *chulas*, where it is slowly dried upon trays over charcoal fires until perfectly crisp.

Drying.

No time must be allowed to elapse between the panning and drying as no opportunity must be given for the leaf to ferment. If the leaf is allowed to undergo any degree of fermentation, the distinctive character of the tea is injured and the result is something like a black tea.

When tea is manufactured in the above manner, it turns out an irregular dirty green colour, not particularly attractive in appearance. The fine leaf may have preserved a clear green colour, but the coarser leaf is a blackish grey and spoils the appearance of the whole. The Chinese long ago recognized the impossibility of making coarse leaves retain their green colour during

manufacture, and they resorted to the dodge of adding a colouring matter, by which the whole tea is faced and greatly improved in appearance. Various substances have been used for this purpose, including turmeric, Prussian blue, indigo, sulphate of lime or gypsum, etc. The colouring pigment is added at the final stage of panning after rolling has been completed. In the Kangra Valley, the substance commonly used for facing teas is powdered soapstone, of which about a teaspoonful is required for four pounds of tea.

Colouring.

Quantity.

Tea, which has not been faced, is variously described as "Natural Green Tea," "Unfinished Green," etc., while the faced tea is often described as "True Green" or "Finished Green." The general feeling of planters in India seems to be distinctly opposed to artificial colouring of any kind, as being undesirable; the finished greens are made only for certain markets where natural greens are not accepted.

Description.

In the early days of the Indian Tea Industry, both green and black teas were generally manufactured; but after a few years the manufacture of green teas gradually ceased, with the exception of a small quantity, which has regularly been made in the Kangra Valley for sale in Persia and Afghanistan. During 1902 a few estates commenced the manufacture of greens, chiefly in order to supply the American Market, which still draws the bulk of its supplies from China and Japan, and which still shows a preference for green as distinguished from black tea.

Revival of green teas.

Whether this preference will be maintained for any length of time is open to doubt. When England drew her supplies chiefly from China, a considerable proportion of the tea consumed was green, but as Indian and Ceylon teas gradually displaced those from China, the trade in greens has been nearly obliterated, athough

Green tea in England.

the trade in black tea from China is still considerable. It is natural to suppose that the same thing may happen in America, but meanwhile the planters of India have adopted the wise policy of catering for the actual demands of the market, until the American people acquire a taste for the more mature and full-bodied beverage.

American market.

In view of the rapid revival of green tea manufacture, several inventors have patented machines for the special work. The panning by hand is now replaced by steaming and draining machines, and another machine has been patented which the inventor claims will combine also rolling and partial firing in the one operation. Special machinery can be obtained from Engineering Firms in Colombo and Calcutta.

Machinery.

" Finished Green " Tea is now being turned out by machinery which, by mechanical means, develops to some extent the necessary colour and bloom without the addition of any colouring matter.

The principle is adopted from the Metal Retorts used many years ago for roasting animal charcoal, required in sugar refining. It consists of a large metal cylinder, revolving horizontally, with heat applied outside. The tea is fed in at one end, and carried along with the aid of floats attached to the inside of the cylinder, and so kept turning over on itself till it emerges at the delivery end.

Glazing.

It is possible to make green tea with the machinery commonly in use for black tea ; although not so efficiently as with the machinery which has been specially designed. The preliminary steaming can be done in any automatic drying machine. No steam has to be added to the leaf, as the moisture within the leaf itself is sufficient. In hot weather a sprinkling of hot water must be added. The machine

Steaming Rolling.

is run at a fast speed, the leaf fed into it about two inches deep. The temperature about 200 degrees.

On delivery, the steaming hot leaf is immediately transferred to a rolling machine, where no pressure is applied until the mass has become thoroughly aërated by running loosely in the machine. The pressure cap is then gradually brought to bear upon the mass, until the leaves are slightly bruised and curled.

As soon as the roll has quite cooled down it is removed for a second steaming. This cannot be done in the usual automatic dryer, because the leaves have now become very sticky, and are liable to stick to the trays. It can, however, be done in any machine with trays which are manipulated by hand.

The leaf emerges from the second steaming in a very hot state; all ribs and stalks quite flaccid. It is now placed in a roller for final rolling, without pressure at first, because many of the leaf buds are crisp at this stage. After tossing for a minute or two in the machine the tips become softened by steam, when full pressure can be applied, and fifteen to thirty minutes hard rolling is done, according to the character of the leaf.

The mass is then passed to the drying machine, where it is first subjected to a temperature of 220 to 240 degrees, and finished slowly at a temperature of 200 degrees.

Coarse leaf.

After drying, green tea must be sifted with great care, as it is more fragile than black. Coarse leaf is not suitable for making green tea, as it will not curl; it only turns out flaky chips of a yellow colour, disfiguring the finished product.

Commission.

Oolong teas have a special market in America, and when of good quality command a high price. This fact induced the planters of India and Ceylon to make special investigation into the methods of its manufacture, and Commissioners were sent from both these countries to Formosa, where

the true Oolongs are made, in order to find out all that could be gathered about the special manufacture on the spot. The results of these investigations were not encouraging, and the general conviction was established that the peculiar flavour of those teas was due to the special conditions of the soil and climate in Formosa. The Indian Commissioner gave it as his opinion that the flavour was due largely to the particular variety of the tea plant cultivated in Formosa. After all, the market for Oolong teas is a very restricted one, and is probably destined to change in favour of black tea in course of time.

Special variety.

The manufacture of Oolong tea may be described as a cross between that of green and black tea. The leaf is slightly withered before manipulation, and a light fermentation is allowed to develop before the tea is dried. In other respects the manufacture is practically identical with that of green tea.

Manufacture.

CHAPTER XXIII.

BRICK TEA.

BRICK tea is universally consumed in Tibet, hence the planters of India have made many efforts to capture the trade in that article, or at least to gain a footing in it. The Lamas of Tibet have this trade entirely in their own hands, and are very jealous of any interference by Indian planters, recognizing that anything like free trade in the article would mean a certain curtailment of their monopoly, hence they have thus far bitterly opposed and very effectually excluded the Indian article. No doubt in time some Indian tea will find an opening, and a trade be established on some equitable basis.

Tibet trade.

One of the difficulties in competing with the Chinese bricks has been the peculiar character of the article especially the class of bricks which is most largely used by the great bulk of the population in Tibet. The fine grades of bricks made in China are practically just ordinary teas compressed into the form of bricks, but the coarse bricks which are used by the common people of Tibet are made from very coarse leaf and stalks, very similar to the prunings which are annually cut off the bushes by planters in India, and are destroyed or used merely as manure. It is manifestly very important that such material should be manufactured into tea, if a good market can be found for it. The price paid at present for bricks in Tibet would certainly be very remunerative if paid for Indian tea bricks.

Prunings.

These considerations led the Indian Tea Association some years ago to despatch a Commissioner to China, in order to learn on the

Commission to China.

spot the exact manner of manufacture; so as to be able to produce an article having the same flavour and appearance. Some valuable information was collected, which added greatly to the knowledge already in possession of certain planters both in Assam and Darjeeling. The Report * is a highly interesting record of travel in China. Some of the details of manufacture still remain a little obscure, although as a result of experiments, an article very like the Chinese bricks is now being manufactured.

Season.

It does not seem possible to make the proper stamp of brick from prunings only. The Chinese do not attempt it. They make their brick tea in the ordinary manufacturing season: chiefly in the province of Ssu-chuan; but in process of manufacture the fine leaves are set apart for the making of high grade teas while the coarse leaves, stalks and sticks, are used for the production of rough bricks.

Brick Tea can be made from leaf gathered under the system known as "breaking back" or taking the old tough leaves which have perforce to be left by the pluckers when the growth upon the bushes has been allowed to run away too long during the busy season. Leaves which are two or three months old are quite good for making this class of tea.

Panning.

The first process of manufacture is panning, which is done in the same way as already described for green tea. A little steaming previously is a great help to this process. No withering is necessary.

In the heat engendered by the panning, the leaves become a little soft, and they turn olive green in colour.

In practice a very efficient method has been found for wilting the leaf in place of panning. The result is fully as good, and both the cost and the trouble are greatly reduced. The leaf as it comes in from the field

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* Report of a Mission to Ssu-chuan," by Jas. Hutchison, M.A.

is passed through one of the automatic drying machines, now so common in all factories. The leaf is fed in thickly, and the machine arranged to go at its quickest speed. The temperature at first is about 160 degrees, but as soon as the first entered leaf begins to come out of the machine the temperature is put up to about 200 degrees. The leaf comes out of the machine in a very hot steamy state and perfectly wilted.

Rolling.

It is now passed to a Rolling Machine, in which it is rolled for about half an hour; the fibre of the leaves being well lacerated in the process, and all more or less broken. There is no curling, as the leaves are too coarse for this.

Fermentation.

Coarse leaf of this character does not seem to be capable of undergoing the fermenting process usual in the manufacture of black tea. It is substituted by an entirely different process. The leaf is placed in a heap upon a mat, or upon a cement floor, about six inches deep, or if the leaf is very dry it may be put two or three feet deep and covered with a sheet or tarpaulin; in which condition it is left for about five days. The heap generates a considerable amount of heat, and after about two days a black fungus begins to grow amongst it. This fungus is probaby the chief agent in the progress of this class of fermentation, and determines the peculiar flavour which is characteristic of the true brick tea, and it also causes the peculiar black colour of the infused leaves. If weather is favourable, this process may be complete in four days; if cold and inclement, it may take as much as ten days.

Fungus.

Drying.

After fermentation is complete, the leaf is to be dried, either in the sun, or on *chulas*. The tossing over in process of drying dispels the adhering fungus; and the leaf, being now dry, can be kept any length of time before moulding into bricks.

Sorting.

Before being moulded, the tea requires to be sorted into two or more grades, and all foreign matter picked out. It is then treated with a thick starch, made from glutinous rice or a paste made from flour; after which it is steamed for about one and-a-half minutes, and immediately pressed into the moulds.

For the purpose of steaming the tea, the upper portion of an old updraft Sirocco Tea Drying Machine can be turned into a very effective steam chest. The top has to be covered over with sheet iron, and a steam pipe inserted at one side, to deliver steam from an ordinary boiler. Zinc bottomed trays are used, instead of the ordinary sirocco trays, and the quantity of dry tea for each brick or tablet is weighed for each tray before being passed into the machine. The steaming is sufficient while the trays are passed through continuously.

Moulding.

The moulds used in China are 4 feet long, and 9¼ by 4¼ inches internally, with strips in the corners, to ensure the brick being rounded. These moulds are constructed so as to be detachable. The bulk of leaf, immediately after steaming, is rammed as tight as possible into the moulds; into which has previously been inserted a lining of fine bamboo mat. Each mould holds the material for four bricks of about 4½ lbs. each. After each quota of 4½ lbs. a dividing piece of mat is inserted before the next lot is put in. A block of wood is put into the mouth of the mould, and the whole keyed down very tightly. After about three days the bricks have sufficiently settled to allow of the moulds being opened out, and the bricks packed in paper, and put in the sun to be thoroughly dried.

Moulding Machine.

A hand-power Brick Machine has been found very suitable for moulding the tea into small bricks, or tablets. This is fitted with moulds to produce tablets, like tiles, about four inches

square, and $1\frac{1}{4}$ inches thick, weighing $\frac{1}{2}$ lb of tea. One turn of the machine produces four tablets, and three men can turn out several hundreds of these tablets per day.

The brick which has been described is the ordinary tea brick used in Tibet; and over the greater part of that country it is used as currency for barter of all sorts, and is a standard of value; but there are various sizes of bricks in use by the more wealthy inhabitants, the finer grades of tea being put up into smaller sizes of bricks. Tablet tea is no doubt also used; but is made in China chiefly for the Russian trade.

Mouldiness.

A most important fact to be noted is that the steaming and bricking up cannot be done in the winter season, and even the manufacture of the tea is difficult after the month of October. There is in the winter season a remarkable tendency for the tea to become mouldy before it can be dried after steaming; whereas in the summer season this difficulty hardly exists at all.

CHAPTER XXIV.

BUILDINGS.

IT is impossible, within the scope of this book, to go very minutely into the general details of building work; all that can be done is to give a sketch plan of factory buildings, together with a few useful hints regarding preparation of materials, etc., as suggested by practical experience.

When important buildings are in contemplation, it is very necessary to consider well before any definite plan is fixed upon, and to take full advantage of whatever local knowledge or experience is available. All necessary timber should be sawn and stacked to dry one year before being used. The importance of having timber thoroughly seasoned is not so generally recognized as it should be, and in consequence there are many factories and houses with windows and doors as well as flooring boards, etc., in a permanently warped, ill-fitting, and unsightly state. With flooring boards it is advisable, even when the timber is seasoned, to put them down loosely for one year before fitting and permanently nailing them. All timber for permanent buildings should be of the best kind procurable; all posts, beams, door-posts, lintels, and rafters should be of the hardest timber, thoroughly dried and seasoned. Door and window frames may be of light but durable wood. Flooring boards the same. For a permanent factory the columns and girders should be of mild steel: roofs of corrugated iron upon an iron framework.

Seasoned timber.

Quality of timber.

Steel columns and iron roofs.

Foundations. Foundations should, wherever possible, be of stone, otherwise of well-burnt brick of the best quality.

Most tea estates in India require to have their permanent buildings of bricks because of the scarcity of good stone; hence when an estate is commencing to build, it is worth considering whether it would not pay to get a simple style of brick-making machine as well as a clay mill or puddling machine.

Clay and soorkee mill. The latter is a necessity where much building is to be done, and a brick machine also would probably pay itself in the improved quality of bricks, which being denser and much stronger than hand-made, enable the builder to construct his buildings of thinner walls, and so use less bricks.

Brick machine.

Preparation of clay. To make good bricks it is necessary in the first instance to get suitable clay, and to have it properly prepared. The soil should be dug up and watered some days before the final mixing takes place. In English brickfields this is done some months previously. If soil is dug up, watered, and made into bricks all in the same day, the result cannot be quite satisfactory, especially if all the operations are done by hand. After watering, the clay requires time to soak and "ripen."

Selection of clay. If there is a choice of soils for making into bricks, a good plan is to make samples and test them by burning in an ordinary fire.

Vegetable rubbish. When bricks are to be used in their sun-dried form only, a little admixture of vegetable matter does no harm, but if for burning, great care must be taken to exclude from the clay all roots of grass or other vegetable rubbish, because as soon as the bricks get red-hot in the kiln such vegetable matter gets consumed, and the bricks are in consequence more or less disintegrated. As an instance in point, on

Effect of manure.

one occasion, it was found that a large proportion of the bricks in a kiln crumbled away to powder in process of burning, although they had previously passed muster as well-made splendid-looking bricks. It ultimately transpired that the clay had been taken from ground upon which there was a heap of manure; this had been mixed in with the clay, and of course burned away whenever the bricks became red-hot. They made splendid *soorkee.*

Moulding bricks.

It is worth while to spend a little extra time and care to ensure bricks being well made. The clay should be well pressed into the corners of the mould, and the upper surface smoothed off carefully and smartly before the brick and the mould are separated.

Drying.

Before building into a kiln, it is of the greatest importance that the bricks should be thoroughly dry. If damp bricks are allowed to be built in, the whole thing may come to grief, and in any case there will be a great waste of fuel.

Size of bricks.

A very useful size of brick is $10'' \times 4\frac{3}{4}'' \times 3''$, but the mould has to be made a good bit larger in order to allow for shrinkage in drying. About $11'' \times 5\frac{1}{4}'' \times 3\frac{1}{4}''$ will dry to the right size. The width requires to be rather less than half the length, so that two bricks placed sideways, with a jointing of mortar between them, will equal one brick lengthways.

Smaller bricks make a more elastic wall, but they are more expensive to make and take more labour in building, besides requiring more mortar. Very large bricks are no economy, because many of them break in process of drying.

The usual mode of burning bricks on a tea estate is to build a rough kiln or clamp of the bricks themselves in the form of a pyramid, similar to the accompanying sketch. If the length of the furnaces measures about 20 feet and

the height of the kiln is made up of 27 courses of brick on edge, then a kiln consisting of 18 furnaces contains about one lakh of bricks (1,00,000). This allows for some spaces here and there within the kiln which contain charcoal, coal, or other dry fuel, built in with the bricks. Smaller kilns can be made in proportion by having fewer furnaces.

Contents of kiln.

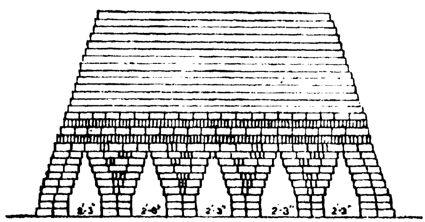

FIG. 27.—BRICK KILN.

In building the kiln, the outer rows of bricks require to be carefully arranged, so as to ensure stability; it is a mistake, however, to arrange the interior bricks too accurately, because a good deal of space must be allowed for smoke and steam to escape. Instances have been known of kilns very carefully built and fitted up, but when the steam began to ascend with the smoke it could not be carried out, and the whole upper portion of the kiln became a practically solid mass, which took weeks before the fire could penetrate it. If the interior is built quite loosely such a result cannot occur. The courses of bricks have to be built lengthways and crossways alternately, all on edge.

Building kiln.

Build loosely.

After all has been built, the outer surface, with the exception of the top, has to be plastered roughly with clay; this is allowed to crack in drying, so that through these many cracks some of the steam from the interor may escape, and the outer bricks, which are protected by the rough plaster, will also in course of time become

thoroughly fired, although perhaps not so perfectly as those in the interior. The top of the kiln is covered with broken bricks, laid flat.

Fuel required.

When wood fuel is used, the quantity required is about 22 mds., or 16 cwts., for every thousand bricks, besides about half a maund of charcoal built in. This is ample, and less will do if the fuel is of good quality.

Firing.

Fire slowly and steadily.

Firing is usually done from both ends of the furnaces. If dry fuel is used, the firing must be done slowly, otherwise, the bricks surrounding the furnaces will be melted into glass before the heat has time to ascend far up the kiln The reason for this is that clay is a very slow conductor of heat, and requires to have its own time. Firing must, however, be as regular as possible, because sudden and repeated heating and cooling tends to crack the bricks. For this reason firing has to be carried on continuously night and day until the work is done. The progress of the heat may be seen at night by the red glow inside the cracks and joints of the wall, and during the day it can be tested by inserting a straw, which takes fire if the redness has reached the crack where it is inserted. When the redness has ascended to three-fourths the height of the kiln, usually 2½ to 3 days, the work is complete; the mouths of the furnaces are closed up with bricks and clay, and the kiln is left to itself. The heat then gradually ascends, and after two days the top of the kiln becomes red-hot.

Closing furnaces.

Cooling.

Cooling should be allowed to proceed slowly and naturally; the mouths of the furnaces are not to be opened for at least a week, as an inrush of cold air might crack many of the bricks.

Selection of site for factory.

In choosing the site for a factory, many things have to be taken into consideration. It is well to be central, if possible, for the

convenient conveyance of leaf from all parts of the estate. It must be on high ground, so as to avoid flooding. It is an advantage to be near a stream or other source of abundant water-supply, but must not on any account be so placed as to be in danger of damage or obstruction from any possible change of the course of a river.

Extra space. There must be ample space of clear ground around the factory for the construction of accessory buildings, such as carpenters' workshop, smithy, etc., and for the storage of a large quantity of fuel for machinery and timber for boxes. **Room for additions.** The actual site of the building should be large enough to permit of additions and extensions in case of the area of tea being increased at some future time, or the leaf from some other garden being brought to it for manufacture, as a result of amalgamation.

Foundations. In constructing a heavy building, the matter of first importance is the foundations. These must be wide and deep; not necessarily of the same depth everywhere, but must everywhere reach a substratum of hard solid ground if not actual bed-rock. The pits for foundations are to be carefully examined at every point before building is allowed to begin.

Concrete. The accompanying sketch shows a section of foundation wall. At the bottom of the pit is first laid a bed of concrete, made of broken stone (small enough to go through a two-inch ring), portland cement, and sand. **Proportions.** The proportions are six of stone, three of sand, and one of cement. If lime is good and cheap, one-and-a-half measures of it may be used instead of the cement. **Mixing.** This should be all mixed together on the ground and slightly watered before being laid in the pit. It should be laid about nine

inches deep, well rammed down and beaten for two days.

Brick concrete. If broken brick is used for concrete, it must be first steeped in water, as it is so porous. The brick must be very hard—glassy kunker being best.

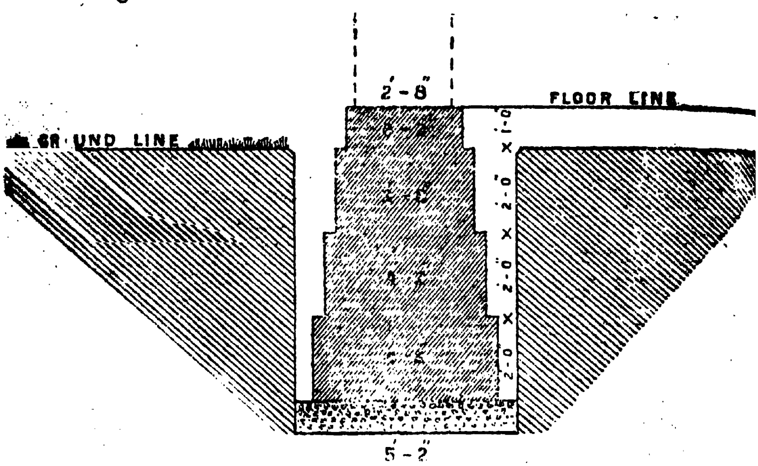

Fig. 28 FOUNDATION.

The first course of the foundation wall must be considerably wider than the wall of the superstructure which is to be built. This is to be continued in regular courses, narrowing gradually till the ground level is reached. A final course is now to be laid with more care, the outer edges being dressed perfectly straight and the top made perfectly level, and finished off about one foot above the level of the ground.

Courses.

The width of this upper course of the foundation requires to be at least six inches greater than the thickness of the wall to be built upon it.

Depth and width.

About 6 feet is a good depth for foundations, provided that the ground is solid, with no part of it "made earth."

recently filled in. The width at the bottom may be double the width or thickness of the wall of building to be constructed. If at this depth the ground is still soft or unstable, the foundation must be made deeper and wider as necessary. A rocky bed is of course the most satisfactory.

Bed.

Brick walls are usually described as so many bricks thick; thus, if our bricks are 10 inches long, a two-brick wall would be 21 inches, allowing for irregularities and for mortar joints.

Thickness of walls.

A good strong wall for a factory can be built three bricks thick, about 31 inches, or 32 inches if the bricks are uneven. This allows plenty of space for mortar, which is very important. If bricks are placed quite closely together, there is great probability that many of the joints will get no mortar at all.

Space for mortar.

There are several systems of laying bricks. The most common way is to lay *stretchers* and *headers* (lengthways and endways) alternately in the same course. The important point is to see that the headers of each course are placed over the centre of the stretchers of the course immediately below it, and that the stretchers are laid so as to cover all the joints and so bind the wall. Whatever system is adopted must be adhered to throughout, and the pattern formed on the wall by the joints should appear uniform and symmetrical.

Brick laying.

Binding.

Mortar should be thoroughly well mixed. Nothing does this so well as a pan (or soorkee) mill, but if done by hand, some pains should be taken to see that it is done well.

Mortar.

For small or unimportant buildings clay is often used as mortar, and is indeed much better than lime mortar when the lime is of inferior quality.

Clay mortar.

For all heavy and important buildings, such as a Tea Factory of more than fifty feet width, the very best materials must be used. The lime used should be freshly burnt and newly slaked. If sand is at all earthy, or mixed with organic matter, it is quite unsuitable for mortar, and even if such sand is mixed with the very best lime, the resulting joint is as soft as clay. River sand is better, but is not quite satisfactory, because all river sand is water-worn and is too smooth to allow of the lime taking a good grip of it. The only way to obtain really good sand is to take a piece of sand-stone and break it down with a hammer, then sift it.

Sand.

Sand which is to be used for mortar should invariably be washed, in order to get rid of earthy matter. This can be done by constructing a trough in a place where a constant stream of water can be led into it.

Soorkee.

Soorkee (powdered brick) is rapidly taking the place of sand; it is wonderfully superior, and for mortar should be used exclusively wherever there is any doubt regarding the quality of the sand obtainable. Wherever there is a brick-kiln there will be a supply of soorkee obtainable from broken or badly formed bricks; but if mortar is wanted for some stone work only, and no bricks are being made, a very simple and efficient mode of making soorkee is as follows:—

Soorkee bricks.

A number of reeds, stalks of elephant grass or sticks, are collected and cut into lengths of 12 inches. A piece of clay is wrapped round each, so as to make it look like a baker's rolling pin. After drying in the sun, these are collected and built into a small kiln and burnt. The burning is easy and expeditious, because the stick through the centre of each brick assists the progress of the fire, and the result is satisfactory. These little bricks are easily broken and powdered down into soorkee.

Proportions for mortar. The proportions in the different classes of mortar are as follows:—

	No. 1	No. 2	No. 3
Lime	1	1	1
Sharp sand	1	1	
Soorkee	2	1	1
Total parts	4	3	2

No. 1 is ordinary mortar; No. 2 is very good; while No. 3 is very strong, and only used for special work.

Goor. Native builders have for many years used *goor* (raw sugar) in mortar which is required to be specially strong; its effect is excellent and is due not to mere stickiness, but to a certain chemical action which the sugar exerts upon the lime, rendering it much more tenacious and effective. Goor should always be used in the mortar for arches.

Steeping bricks. All bricks must be steeped in a tub of water before being laid on the wall, otherwise the mortar will not adhere to them. This is an important matter which must not be overlooked if the buiding is to be satisfactory.

Thin mortar. The mortar has to be made quite thin, and baled on to the wall like soup, so that it runs into every crevice of the joints; the process being repeated until all the joints are well filled up. The mortar thickens in a few seconds after it is put on the wall.

Thick mortar. A thick layer of mortar on the top of each course should not be allowed—only enough for smoothening the unevenness of the surface is required. The courses of bricks should touch at some points.

Plummet. It seems hardly necessary to mention that every course of a wall should be raised perfectly plumb with those below it

The plumb rule is unknown to native workmen, but they use a plummet of simple construction (usually made from a door handle), which is fully as effective, and much more suitable to their ways of working. The bulb of the plummet should always be applied to the lowest course, and each course as it is laid has to be tested and made plumb with the bottom one.

Upper walls. Above the first floor the wall may be reduced in thickness, and again above the second floor. The upper walls have less to carry, and do not require so much strength.

Portland cement. Portland cement is used very largely in India. For the ground floors of tea factories it is excellent, when properly laid, and it is largely coming into use even for upper floors of large buildings. **Fireproof floors.** Steel girders are made to support low arches made entirely of cement concrete, which eventually hardens into one immense stone slab, becoming more and more hard and indestructible as time goes on.

Some cement sold in India is of very poor quality, being little better than clay. English Portland Cement has a high reputation.

Cement floors. Ground floors require to be about one foot thick. First is laid a layer of large flat stones or good hard brick, well jointed with the best mortar; then a layer of concrete, similar to that already described for foundations. This has to be beaten continuously with heavy rammers for some days; sprinkling with water as necessary. The finishing layer of cement mixed with sand has now to be laid on; it must **Thickness of cement.** be *not less* than one inch thick, and if a really good floor is wanted, 1½ inch or even 2 inches may be put down. A thin skin of cement is quite useless, and involves endless trouble and expense for subsequent repairs.

On the day after cement is laid down, it has to be beaten very gently by hand, with small wooden beaters; neglect of this will result in the floor cracking and warping when drying. No water is to be sprinkled at this stage until the cement is nearly set; it is then to have a very little sprinkled on the surface and be smoothed over with the finishing trowel.

Floor cracks.

Immediately after the work is completed, the floor is to be covered over with sand, to a depth of three or four inches, then douched liberally with water. The watering-can is to be used every day and the sand kept soaking wet for at least a month. Any kind of sand will do; its object is merely to protect the surface of the floor and to keep it wet. When the cement has set and become quite hard, the watering may be discontinued and the sand removed.

Cover of sand.

Watering floor.

Cement for floors should be the best quality obtainable, and quite fresh. When used without admixture of sand, it is of course expensive, and the floor is as slippery as glass hence sand is always used in greater or lesser proportions as follows :—

Proportions for cement floor.

	No. 1	*No.* 2	*No.* 3
Cement	1	1	1
Sharp sand	4	2	1

No. 1 is the usual mixture, and is quite strong enough for ordinary purposes, especially if laid down thickly. No. 3 is very strong, and may be used for the packing room, or any floor which will be subject to much ill-usage.

Pure cement only should be used for repairing cement floors; if sand is used, the new patch will break away again. The patch has to be surrounded with a ring of clay and kept under a pool of water until the cement hardens.

Repairing floors.

Effect of time.

Cement floors require to be used very cautiously during the first year. Loose boards should be laid down, wherever necessary, to protect the surface. After a year or so the cement gets very hard and eventually becomes like granite. This may be tested by laying aside a little cake of the cement mixture and examining it from time to time; at first it will powder down easily between the finger and thumb, but after two years it is like a bit of hard sandstone or slate.

Sand for cement.

The quality of sand for mixing with cement is of great importance. The surest way to get the proper article is by breaking down soft rock and sifting out the sand thus obtained. The sand must then be thoroughly washed.

Ferro-concrete.

Reinforced concrete, or ferro-concrete, is now coming into general use in many places, especially where space is limited, or where building materials are scarce. It has already been adopted in the building of some large tea factories, and is certain to come into very general use for partitions and other light work in almost all new factories. In situations where stone is scarce, and where suitable clay for brick-making cannot be found, it seems destined to prove the favourite material. There are some tea districts where the only stone to be had is in the form of rubble in the beds of streams, or on the outcrop of gravelly seams on poor land. These water-worn stones can be broken down to form excellent material for ferro-concrete. Broken pieces of hard burnt brick also form excellent material. Already in some parts of India buildings of all kinds have been constructed of ferro-concrete, and thus far with entirely satisfactory results. Walls, pillars, upper floors, balconies, roofs, etc., being made entirely of this material. It has been proved that these buildings can be subjected to considerable strain without the slightest damage.

It is necessary, however, that anyone who contemplates adopting this style of building upon any great scale should first gain some practical knowledge of the details of the work, or should employ a technical adviser to scrutinise the plans and to inspect the work.

The usual proportions of materials for ferro-concrete are as follows :—

Broken stone	5	measures.
Sand, well washed,	2½	measures.
Portland cement	1	Do

The stone should be broken small enough to go through a one-inch ring or mesh. For thin walls, the stones must be small enough to go through ¾-inch mesh. The cement must, of course, be of the best quality. Main walls should be 4 inches to 6 inches thick. If upper floors are to be carried, there must be at intervals piers of double the thickness of walls. For very fine work the stone must be broken so as to pass a ¼-inch mesh.

The steel rods for reinforcing require to be arranged differently for different classes of work. When there are piers in the walls, the main rods are placed horizontally, from pier to pier. Main rods might be ½-inch diameter, subsidiary rods ¼-inch. The subsidiary rods in this case are placed vertically, at intervals of 18 inches, and interlaced where convenient with the main rods, which are from six to nine inches apart.

If there are no piers, the main rods are placed vertically to reach from floor to floor, and the subsidiary rods horizontally.

Partition Walls.

The rods are arranged preferably 1 inch from each surface of the wall and not in the centre of the thickness ; then a board framing is set up to form a trough about 12 inches high, and the thickness of the required wall. The concrete is then rammed in and well beaten down. The trough arrangement is moved up as the concrete hardens, keeping always perpendicular. When long buildings of

concrete have to be erected it is advisable to have partition walls in the interior, binding the main walls together at intervals as frequently as may be practicable.

Columns. In building columns, the general rule is to give a reinforcement of steel measuring 1% in the section of the column. A column of 9½ inches diameter requires to have four main rods of ½ inch steel placed vertically. These are bound horizontally at intervals of 9 inches, with thick wire, or ¼ inch rod iron.

Such a column 10 feet high, is reckoned to bear with safety a load of 12 tons.

Upper Floors. For concrete upper floors or roofs, the most convenient material to use for reinforcement is expanded steel. Concrete beams should not be attempted unless under the direct supervision of an expert. If the floor is supported by steel beams or girders, these must be sufficiently strong to ensure that there will be little or no deflection, otherwise there would be danger of the cement floor cracking. When the girders have been placed in position a temporary plank-flooring is to be arranged between the girders, so that the upper surface of the planks will be in line with the lower edge of the upper flange of the girder. The expanded steel is now laid from girder to girder.

For an ordinary floor, say 4 inches thick concrete, the expanded metal is ordinarily ¼″×⅛″ metal and 8″×3″ mesh.

The concrete used for this work should be a little stronger than that used for walls, and may be 4, 2 and 1 parts of stone, sand and cement, respectively.

The concrete is spread over the expanded metal to a depth of 4 inches, and well beaten down. It is sometimes advisable to have embedded near the surface of the floor a strip of the expanded metal, say 2 feet

wide along the line where each girder occurs, the strip running in the same direction as the girder.

A floor of this description, with the girders 9 feet apart, will safely bear a load of one cwt. per square foot.

Steel Columns. No steel columns should be constructed within concrete walls, as has already been done in some cases by inexperienced persons, unless these are well embedded in concrete all round, otherwise they may become a source of weakness instead of strength.

Concrete walls should be continuous, without a break of any kind. Steel columns may, of course, be used for supporting floors, instead of the concrete columns above described, but will be much more expensive.

Plan of buildings. The plan of factory buildings, which accompanies this, is meant to suggest a suitable arrangement of the various departments; the actual plan has to be made to suit local conditions and requirements. The buildings shown are suitable for manufacturing an annual crop of about ten thousand maunds of tea (800,000 lbs.).

Dimensions of factory. The main building measures internally 300 feet by 60 feet; with a wing projecting from the centre towards the north measuring 100 feet by 60 feet. This building supports two upper floors, besides a light floor fixed to the tie rods of the roof, which merely acts as a ceiling to the second floor, protecting it from the heat of the iron roof. It also supports a double-storied verandah along the whole front and back—all glazed, except the parts opposite the rolling room, which are left open for free circulation of air, and for coolness. The roof of the main building is continued straight over the verandahs without a break. The verandahs are each 20 feet wide; so that there is a ground floor space of 300 feet by 100 feet and 80 feet

Floor space. by 60 feet. The first floor measures the same, and the second floor 300 feet

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Floor space. by 60 feet. The first floor measures the same, and the second floor 300 feet

by 60 feet and 100 feet by 60 feet. Each upper floor has a ceiling to shut off the heat of the roof. The floors for withering consist of battens covered with bamboo matting.

All the floors immediately over the machinery should be made fire-proof: either of concrete as already described, or of iron: so that in case of fire the machinery at least will be safe.

The height of the first floor from the ground is 12 feet, from that to second floor $7\frac{1}{2}$ feet, and again to ceiling 7 feet. The upper floors can be arranged throughout with withering racks; fans being placed in the centre to draw the air from one end and discharge it through the other as required.

Fans.

This style of factory can be built in detail, for any garden where the crop is gradually increasing. Part of the rolling room can be used for fermenting when necessary, but this will generally be done in the wing on the north side. This wing can also have verandahs attached if necessary.

Water.

Water should be laid on to the factory in pipes. It is customary in factories, which depend on wells for all their water, to have a small engine for pumping water up to large iron cisterns, which are perched upon piles or upon an iron framework something like the Eiffel Tower. From these cisterns the water is led in pipes to all points as required. The fermenting room requires to have an abundant supply, and it is a great convenience to have the water in a masonry trough all along one wall.

Rails trolly.

No rails should be laid inside the factory. Leaf in process of manufacture can be carried from one part to another on trollies with wooden wheels which cannot damage the floor; a three-wheeled trolley, one wheel being on a swivel, is a most convenient means of moving leaf from machine to machine.

A strong trolly can be made, having two wheels pivoted, each pivot being a long bolt carried in bearings fixed to a fender standing upright at one end of the trolly.

Position of godowns. The leaf houses for cool withering require to be convenient to the main building; but if roofed with thatch, they must be sufficiently distant from the chimneys, etc., to be quite safe from fire. The same may be said of the carpenter's shop and the godowns for storing fuel, etc., 100 feet is the minimum distance allowed in fire insurance policies.

Leaf houses. Leaf-withering houses are usually made with the sides quite open, but with some arrangement of movable mats or blinds to shut off the direct rays of the sun or exclude rain when necessary.

Chungs. The old style of leaf house has two floors. Between these floors are erected *chungs* of bamboo work or battens, covered with bamboo matting. The *chungs* are 3 feet apart, to give just enough space for boys to creep in and spread the leaf, and they are erected over the whole floor space, with the exception of a passage down the centre running the whole length of the leaf house.

Withering frames. Some factories have their leaf houses fitted up with frames, with either wire mesh or open woven Hessian cloth. This is a better plan as it economises space, and it gives the factory manager or assistant an opportunity of inspecting the leaf spread at every point without having to creep under a three-foot chung. The one thing to be specially guarded against is putting the tiers of wire or cloth too closely together; they should be not less than 9 inches

Close tiers. apart; 12 inches is a good distance as there are no fans in these houses to circulate the air.

A few factories in Assam which had adopted the system of withering frames have gone back to the *chungs*.

Both systems have their advocates, and it may be assumed that in a fairly dry climate the frames are suitable; but in any district where withering is difficult on account of frequent and heavy rain the open *chungs* are more effective.

Before erecting a leaf house, note should be made of the prevailing direction of the wind during the manufacturing season, and the house erected so that the wind shall blow across the house and through between the frames or *chungs*.

Fire.

The loss of a tea factory by fire is, of course, a very serious matter, especially if the disaster occurs at a busy time, and if there is no other factory in the neighbourhood which can be got to manufacture the tea. Fire hose may be of some use on the outbreak of fire if there is a good head of water and if the matter is taken in hand promptly; but anyone who has seen a large building in England ablaze, with a dozen hose playing upon it in vain, can realize how hopeless it is to attempt to put out a big fire with one hose pipe, after the fire has got fairly under way.

Caution.

The planter must depend more upon caution and care in preventing the occurrence of fire than upon measures for putting it out, although the latter are certainly not to be neglected.

A few chemical fire extinguishers can with advantage be placed at various points in the building especially in the withering lofts. These are of great use in case of fire from the upsetting of a lantern, or similar accident, provided it is discovered at once. The "Minimax" Extinguisher has much in its favour.

Naked lights.

Only good lanterns in proper repair should be permitted within factory buildings—no naked lights upon any account. Where the electric light is in use, there is less danger of fire, but even with it there is necessity for precaution in fixing up and arranging the wires, so that in case of fusion, which

sometimes does take place, there would be nothing combustible at hand to catch fire. Safety plugs are of course necessary for all electric plant.

Lime washing.

A great help against fire is to have the underside of rafters and battens whitewashed with lime, especially those just over drying machines. It sometimes happens that fine fluff collects in the air tubes of a dryer, and if the tubes get red-hot, this fluff takes fire; the fire is carried to the tea in the drying chamber, and by the action of the fan within the machine the whole thing is soon in a blaze. It is obvious that the air tubes should be cleaned out periodically so that no fluff is allowed to collect in them, and in that case no fire can reach the tea.

Dryers on fire.

Night work.

Night work should be avoided if possible. The teamen should be encouraged to get to work very early in the morning and get the day's work over before dark.

Thatch.

Thatch roofs are always dangerous and should not exist within a hundred yards of a factory.

Hill factories.

On hill gardens, the factories have to be made to suit their circumstances. In many instances the choosing of a site is not an easy matter. Water-power is the first consideration if it can possibly be obtained. The building must be in a secure place however. Instances have been known when a factory has been carried away bodily in a night by a stream changing its course. It sometimes happens that a certain portion of a factory is liable to be inundated and actually silted up more or less during heavy speils of rain.

Natural site.

It is very seldom that a site for factory buildings can be obtained without levelling down to some extent; but a natural site should be chosen, if possible, on secure ground and in a convenient place. It must be near the cooly lines so that the labourers

may not have far to go home after bringing in their leaf. It should also be convenient to the houses of manager and assistants. It is well also that the factory should be at a convenient place from which the manufactured tea can be taken to the railway; this is not so important, however, as the carriage of leaf to the factory, because it takes four maunds of leaf to make one maund of tea, and the carriage of leaf is heavier in that proportion.

Transit.

In levelling the site for a building, the natural condition of things becomes altered, especially as regards drainage. The vegetation is carried away and the soft surface soil is removed, so that all the water, which would formerly have soaked into the earth, now flows over it, seeking some means of escape. If the site were made absolutely level—this water would flow away equally at all points, but in practice such water finds out a depression, and the whole soon tends in that direction, and makes for itself an everdeepening watercourse. If the water is allowed to collect and flow over a bank of made earth, half-an hour

Levelling site.

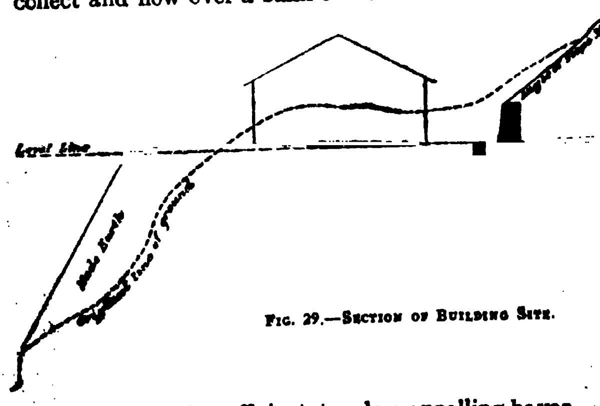

FIG. 29.—SECTION OF BUILDING SITE.

of heavy rain is sufficient to play appalling havoc. For this reason, a new site must be made to slope *inwards*—as shown in sketch

Slope inwards.

so that all water will flow towards the hard ground where a drain must be made to receive it. This drain must be continued so as to carry away the accumulated water and deliver it at a safe place where there is a natural outlet

Drain.

For levelling sites for buildings the instrument known as Bald's Self-registering Clinometer is very useful; it can be operated by any one for work of this kind without any special knowledge of surveying.

The bank of made earth is to be left especially high the first year, to allow for settling down after it gets wet.

Made earth.

Whatever buildings are put up must be on the hard ground. On no account must a wall be built upon made earth.

Angle of slope.

The bank which has been cut into, if composed of soft earth, must be sloped off above the site so that the angle will not be greater than 37°, which is considered a safe slope for an earth bank. If the angle is greater than this, it must be strengthened and altered to this slope by a masonry revetment

If a site is liable under any circumstances to damage by landslip from above, it is not a suitable place for building upon.

Small sites.

One of the most common errors hitherto made in levelling sites, has been in leaving them too high and small, whereas another two or three feet cut off would have resulted in much more space. This work is, of course, very expensive, but if permanent buildings are to be put up, the work of levelling is done once for all, and it can never be improved or done over again after the buildings have actually been erected.

Planting slopes.

Any moderately steep slopes above a building site should be turfed and planted with deep rooting trees or shrubs. They should

not be cultivated or anything done to loosen the soil, which might produce a landslip.

Room for extensions.

A site should, if possible, be chosen which will be capable of extension at some future time for additional buildings if necessary. A very common error in the past has been to begin building upon a site which was naturally too small, and in course of time, as extensions have become necessary, various buildings of an unsuitable nature had to be built upon huge terraces supported by costly revetments. It is better to go to the expense and trouble of selecting and cutting a good large site at the start.

Costly terraces.

Compact buildings.

It is well, if possible, to have but one building for manufacture; but sometimes the nature of the ground does not permit this. The important point is to have the buildings as compact as possible.

Area of buildings.

The size of the buildings to be erected may be regulated by the rule that for a garden making 1,000 maunds of tea, the buildings for manufacture (exclusive of godowns for fuel, stores, etc.) should cover an area of not less than 5,000 square feet. For a garden making 2,000 maunds tea not less than 9,000 square feet, and so on. A large crop requires proportionately less area. It is false economy to curtail either buildings or machinery.

CHAPTER XXV.

Cooly Lines.

Materials.

Any Tea Estate is happily situated which has an abundant supply of bamboos and thatching-grass available for the building and repairs of Cooly Lines. Permanent buildings of brick and iron are not so desirable as at first sight appears, the reason being found very largely in the fact that the garden cooly has not as yet learned the value of cleanliness and sanitation within his home, and any structure which requires to be entirely renewed at intervals is preferable to a permanent building which shelters an accumulation of undesirable deposits in corners and recesses for many years.

Villages

If possible, coolies should be located in villages at various points on the estate, rather than congregated at one or two points only. There are various reasons for this. It is much easier to control and restrict the scope of any epidemic which may break out at any time if an affected village can be immediately segregated from the rest of the population. It is also an easier matter to deal with any insubordination, or disaffection, if the labour force is divided up variously. Sanitary measures are also easier of accomplishment.

The site to be chosen for a cooly village is fully as important as that of the Factory. In the early days of tea more than one Tea Garden in Assam was almost shut down as a result of serious ill-health in the labour force, directly traceable to an unhealthy site having been chosen for the cooly lines.

The lines must be upon high land which is never liable to inundation; preferably with a light or gravelly soil, not clay. On a hill garden a ridge or the face of a mountain spur is ideal.

It is desirable that the floor of each house should be raised at least eighteen inches or two feet above the surrounding ground level.

Construction.

Modern medical science has proved the great value of fresh air in dwellings; especially in those of the poor. Thus it is shown that the ancient custom of having the walls of houses constructed of split-bamboo or lattice-work is the best possible style for present day, as it ensures ample ventilation. No roof is so good and wholesome as a good one of thatch, which protects the inmates from the fierce heat of the tropical sun as no artificial roof can do.

The roof should be constructed with open spaces at the gables, for the free passage of smoke and foul air.

Where masonry lines with iron roof have to be used the best that can be done is to see that the roof is underlined with a ceiling of some non-conducting material, and that the walls in the interior are limewashed once a year. All intelligent coolies are very grateful for the periodical limewashing, as it kills out vermin in the crevices of the walls. Long lines of apartments are not desirable. The coolies like to have their houses erected in pairs only, like semi-detached cottages, back to back for preference. This method ensures that there is no back yard to receive offensive deposits, and all the clear space is in front and at the sides of the house. Plenty of clear space should be allowed, and the people encouraged to cultivate these spaces.

All high-growing crops, such as Indian corn, should be prohibited near the houses, as these obstruct the free passage of air.

A plentiful supply of good drinking water is of enormous importance, and it is well worth while for any estate to go to great expense, if necessary, in order to secure this.

Water supply.

On some estates water is pumped from wells into elevated iron tanks, from which it is distributed to the lines in pipes by gravitation. This is excellent; and if good water can be obtained at a higher level than the estates some miles away it is good policy to spend even a very large sum in supply-pipes in order to obtain it. A fact to be noted in this connection is that wherever there is a considerable difference in level between the source and the delivery, a comparatively small pipe will deliver quite a large quantity of water.

It is an old saying that "an ounce of prevention is better than a pound of cure." This is constantly illustrated in the care and management of the labour force

Malaria.

The universal and regular treatment by quinine has done much to reduce the ravages of malaria but a good deal more is still possible, by the systematic banishment of the conditions which are known to be conducive to the propagation of malarial mosquitœs.

Mosquitoes

It is now well known that all ponds and similar places with stagnant or sluggish water form perfect incubators for mosquito larvæ, but it is not yet sufficiently realized that every little pool of water by the roadside and every old tin or broken vessel lying about, if still capable of holding a little water, is a source of danger during the rains. Garden drains which are faulty in alignment, owing to depressions at intervals holding back water, or drains which have become blocked, are perfect receptacles for mosquito colonies. Bamboo uprights used for supporting fences round cooly locations, and even around tennis courts, are favourite haunts of the anopheles mosquito. The

cavities at the upper ends of the uprights are kept more or less filled by frequent showers of rain, and any one examining one of these in the month of July would be startled by finding it full of the dangerous larvæ disporting themselves. All such bamboos should be cut close to the solid knot; while as regards bamboos already in position, the cavity portion should either be cut off or filled up with clay, so as to ensure that no rain water will find a lodgment.

Sanitation.

Proper sanitation around cooly lines is now receiving much more attention than hitherto. The importance of the subject is receiving more recognition. As a rule, the only hindrance, to effective measures comes from the coolies themselves many of whom positively prefer conditions involving the sure spread of disease.

With regard to the disposal of night-soil, the best authorities used to aim at having it trenched into the land as soon as possible, and it is said that the Chinese observe this plan almost to perfection, economising to the utmost in the use of all material which is capable of adding to the fertility of their soil. In India, however, the attitude of the workers themselves renders any measures of this sort out of the question.

Hook-worm. Septic Tanks.

The recent researches into the details of the disease now known as ankylostomiasis, or hook-worm disease, have emphasized the value of the septic tank, as it has been found that the eggs and larvæ of this worm are killed in such tanks, whereas such larvæ when on or near the surface of the ground have the power of attaching themselves to the feet, and can make an entrance into the human body through the skin at any point. The investigations carried out some time ago by Major Lane in the Darjeeling district during which many thousands of persons were examined, brought to light the startling fact that more than 75 per cent. of labourers of all grades were harbouring hook-

worms. The abominable custom of the native cultivator just leaving dejecta lying anywhere exposed on the ground is the source of widespread disease, and the cause of almost all the complaints of laziness or inefficiency. It is now recognised that in most cases laziness is not a mental offence but a state of disease; and the removal of the cause results in a very large increase of efficiency.

It has been found that when a person is suffering from this disease his stools inevitably contain eggs of the worms. These eggs which are microscopic in size, retain their vitality for a long time, and ultimately hatch out when under favourable conditions of damp soil. The theory is that the resulting larvæ, being extremely minute, are able to penetrate the skin of a person's feet, and are then carried to other parts of the body by blood circulation, eventually attaching themselves to the intestines, where they come to maturity.

Under suitable medical treatment the parasites can be expelled in a very short time. They are about half an inch long, of the thickness of coarse cotton thread, tapered to a fine point at both ends.

Where insanitary conditions prevail, this parasite is rapidly propagated, especially where people go about with bare feet. It has been proved that in many places fully three-fourths of the labouring population are suffering from the disease. The most common symptoms of its presence in a patient are anæmia and listlessness.

Experts have proved that the careful use of septic tank latrines give perfect immunity from attack, because the eggs of these and other similar parasites cannot survive in a septic tank, and the natural method of propagation thus disappears.

An illustration is here given of a latrine similar to one which was constructed by the author, and used on a tea estate experimentally, under the directions of the Sanitary Commissioner, and the plans of the Sanitary Engineer

for Bengal. The present plan shows considerable alteration, so as to promote facility in cleaning out the sludge at suitable intervals; whereas the original was a masonry tank built into the ground. Similar masonry latrines are now in general use in connection with many large factories in and near Calcutta; the larger ones being multiple privies, with troughs along which the material is propelled into the septic tanks.

The illustration shows a tank of galvanised iron, resting upon a foundation above ground, surrounded by a lightly built hut, merely composed of strong posts, to which mat walls are attached, and surmounted by a roof of thatch. The platform is approached by means of a few steps; but in circumstances where the ground is hilly the site can be arranged as a cutting into the hillside, so that access can be had to the interior direct from ground level, or by means of a short inclined plane.

For the effective action of the tank, the addition of water is necessary, in the proportion of about half a gallon per user each day. More may be added, but there is a limit beyond which the superabundance of water renders baterial action in the tank less effective. The septic action is very simple, being originated and carried out by natural bacteria contained in the material itself. The tank must be filled with water before being put into use, and a small quantity added daily, as above mentioned, either by means of a continuous trickle from a pipe or in bulk just after use. The septic action comes into evidence after a day or two, and is in full action after two or three weeks. A scum has then formed upon the surface of the water, and the overflow from the effluent pipe is a trickle of clear water, perfectly inodorous and inoffensive.

The action can go on for an indefinite time, the night soil being decomposed and turned into liquid by the action of the bacteria. The only difficulty arises from the presence of extraneous material, paper, sticks, stones,

etc., which the users throw into the tank. In course of time the sludge thus formed must be cleaned out. This condition occurs probably after the lapse of one or two years. The plan illustrated shows the tank placed above the level of the ground, and so arranged that the covering platform can be raised and lashed to the side of the hut, while the tank itself is turned over on its side by means of light pulley blocks, or any suitable tackle, and the sludge expeditiously tilted out. It is then re-erected and the mat walls replaced, refilled with water, and again ready for use.

The tank shown is for the use of about twenty persons. If a larger tank of similar design is used, which would be too heavy for turning over, it can be made with a sludge door bolted low down on one side, through which the tank could be cleaned out when necessary, without disturbing its position.

An "antisplasher" attached to the tank is not advisable. There is occasionally some inconvenience to users from splash at first; but this disappears as soon as the scum forms on the surface of the water. An antisplasher, or a "cone" cannot be kept properly clean, and is consequently a source of danger to health. The one thing necessary in using the tanks is to make sure that the superstructure is kept scrupulously clean.

It may not be possible to provide all cooly lines with septic tanks; but it is strongly advisable that two or more should be provided at every factory, for the use of operatives who are at work there all day. Anyone who is genuinely anxious to do the best possible for his labour force would no doubt obtain valuable advice and assistance from the Sanitary Commissioner, who can supply copies of designs suitable for the circumstances of any factory or estate, and who is prepared to assist in the interests of public health.

It is necessary to sound a note of warning against the use of carbolic acid or other antiseptics with the water for

cleansing the platforms of these latrines. Such drugs entering a septic tank have a disastrous effect, by killing or destroying the efficiency of the bacteria upon whose action the whole success of the system depends. The platform should be sluiced with plain water once or twice a day, and scrubbed with a rubber squeegee, which can be easily and effectually cleaned after use. Ordinary mops or brushes are just disease carriers.

The septic tank system may not be applicable generally on tea estates; but something very closely allied to it is quite practicable, and has on some estates proved fairly efficient, besides being inexpensive.

A pit is dug in the ground $4' \times 2'$ and 6 to 10 feet deep. This is covered over with a platform composed of strong bamboos laid side by side, arranged with a hole in the centre 12 inches square. A hut of grass or matting is erected round this, and the latrine is complete. The cost of this arrangement is only about one-and-a-half or two rupees. Two men can dig the pit in one day, and on the following day two men can erect the hut from materials previously prepared. In a short time the latrines become almost as innocuous as the pucca septic tank and of course very much cheaper. Everything depends on the platform being kept quite clean. This is not practicable if any latrine is made to serve the purpose of several families, but where one is provided for each house, the system succeeds excellently. One thing to be noted is that the latrine must be located within 20 or 30 feet from the house, as the cooly will not go further. This is because of the natural or superstitious dread of the native to go far afield on a dark night.

Latrines.

Although ordinary labourers will not on any account handle night-soil, they can be made to scrape up all sorts of rubbish; and it has been found a good plan to arrange for a certain number to thoroughly scrape around each village once a week; by preference after bazaar day,

when all offensive refuse can be collected and placed in conservancy pits for use as manure after decomposition.

In dealing with this subject it has been necessary to go into some unpleasant details; but the circumstances warrant this. The proper management of any community requires that some one should see to the details of sanitation; while the labourers on a tea estate are themselves so indifferent, and in some cases so resistent to the most elementary principles of this natural science, the Manager is bound to give it his most serious attention in all detail.

CHAPTER XXVI.

MACHINERY.

So much might be written regarding machinery for a tea estate, that to deal with it fully would require a separate volume. The intention here is to give a few practical hints which may be useful for planters who have not had special training in this line.

Special knowledge necessary.

The use of machinery in tea factories has so much developed of late years that a special knowledge of the subject has become of great importance to both Manager and Superintendent. There is the question of choosing the best kinds of machinery from time to time, as required, as well as the proper measures to be taken for the care of engines, boilers, etc., so as to make them do the full tale of work with the minimum of fuel and yet live as long as possible.

Water-power.

A factory is happily situated when it has water-power available on the spot. The saving in fuel is enormous, being about 65 per cent. of the total quantity otherwise required. When the working parts are driven by water-power, the only fuel required is the quantity necessary for the furnaces of drying machines, and perhaps for heating the withering lofts occasionally.

The most effective way to utilize water-power is by turbine.

Turbines.

Turbines can be had suitable for high or low falls, The higher the fall, the less volume of water is required. If a turbine proves incapable of the amount of work required of it, the fall may be added to, and additional power thus obtained,

provided always that the turbine has been constructed to stand the extra pressure which a higher fall entails.

If there is a sufficient volume of water obtainable—a large turbine with low fall and moderate speed is best, because there is much less wear and tear, besides less fear of a break-down.

Pelton Wheels.

For a very high fall, the Pelton Wheel is perhaps the best motor, as it does not suffer so much from friction as the ordinary turbine. For all classes of turbines, water requires to be carefully screened at the source, and should also pass through one or two settling tanks before reaching the main tank to which the turbine pipe is attached. When tanks are constructed of masonry, they require to be very strongly built, in order to resist the pressure of water, and to ensure that there shall be no possibility of leakage. Each tank requires to have a sluice door at bottom level, for the purpose of periodical scouring out.

Screening.

The purifying of the water is of special importance in the case of a very high fall, when the least admixture of fine sand grinds away the core of the turbine with remarkable rapidity.

Friction.

Sometimes a factory is so situated that water-power is not available on the spot, but can be had at the distance of perhaps half a mile or more below the site of the factory. A turbine has sometimes been made use of in such cases, and the power transmitted to the factory by means of wire ropes carried upon pulleys.

Haulage.

Up to a distance of 2,000 feet this system has been found to work very satisfactorily, but beyond this the loss of power by friction becomes too great. It has been ascertained by actual experiment that for an installation of one thousand feet distance, about ten per cent. of the total power is

Friction.

absorbed in overcoming the inertia and friction of rope and pulleys alone, when unloaded.

For carrying the rope, the driving pulleys require to be packed with hard wood. It is important, however, that the groove in the pulley for receiving the packing shall be rectangular ; so that in case the rope wears its way to one side of the pulley, it will still be bearing directly upon the wood packing.

Carrying pulleys are better not to be packed at all.

For ropes conveying 60 to 100 horse power, the speed should not be greater than 2,000 feet per minute. A very high-speed soon wears out both ropes and pulleys. It is well to have the installation fully fifty per cent. stronger than the circumstances require, because when run at full power there is considerable slipping of the rope; which causes very soon wear and tear.

Compressed air

Another means of transmitting such power is by compressed air, but it has probably not been sufficiently tested in connection with this kind of work.

Electricity.

The best means of transmitting power is undoubtedly electricity, which is destined to be largely used in future by factories which are within a few miles of any of the haunts of the "*Water Giant.*" On some estates an arrangement of this sort has already been constructed and is working satisfactorily: the two chief hindrances to its being generally adopted are the first cost of the installation and the want of practical knowledge necessary for running electric work.

Steam engines.

The steam engine is at present the most suitable motor on the great majority of tea estates. The best type of engines are cheapest in the end. This does not mean that the most expensive or the most complicated engine is to be chosen, but it should be one produced by a firm which can be

relied upon to supply a thoroughly good article, well balanced and carefully fitted in every detail.

Compound engines. In the case of small engines, the simpler the style of construction the better. A compound engine should not be thought of unless it is to be of 20 h.p. or over.

Vertical engines. For small engines up to 10 h.p. the vertical shape is the most economical and lasting, although it may not look so imposing as the horizontal. In the vertical engine, the wear on the piston and interior of cylinder is quite even, and is very slight, so that after ten years' use the piston is probably almost as good as new, whereas in the horizontal engine the weight of the piston, etc., tends to make it wear down and become uneven, the cylinder itself getting worn slightly oval, so that in course of time a good deal of steam passes the rings, involving a continuous waste of power and of fuel.

Oil fuel. Oil engines are rapidly coming into favour, especially for factories of moderate size. Even for steam engines it is found economical to use oil fuel in places where coal is scarce or expensive. Boiler furnaces can easily be altered and adapted for burning oil.

Waste of power. For a large factory, it is not advisable to get one great engine, capable of driving the whole of the machinery and some power to spare. The larger the engine, the greater the amount of friction on the working parts, so that, when very little leaf is coming in and only two or three machines are at work there is great waste of fuel in running an engine of, say, 40 or 50 h. p. in order to work them. The same thing occurs when, during the night, withering fans have to be run, although no other machinery is required at the same time.

Auxiliary engines. The better plan is to have one engine which is capable of driving the greater part of the machinery, with one or two auxiliary

engines which are capable of working a small portion of the machinery when the factory is not in full operation. Where more than two fans are required for withering purposes, it will pay to have a small engine to work these alone.

Bedding.

Engines, and indeed all heavy machinery which is subject to vibration, should be bedded on concrete, and fixed with holding-down bolts, whose heads are well buried in the concrete, so that the whole frame may be held perfectly rigid. The practice of fixing machinery to blocks or beams of timber is a mistake, and often a source of much trouble.

Boilers.

In large factories, the steam required may be generated in large stationary boilers. Two or more improved Cornish boilers make perhaps the most simple and efficient arrangement. They should be arranged so as to be capable of all being coupled together, or used singly. When the factory is in full operation, it is best to have the boilers coupled together, as the pressure can then be kept more uniform. Where fuel is scarce and expensive, water-tube boilers are perhaps best.

Water-tube boiler.

All persons who have anything to do with the working of steam boilers, do well to note that a considerable responsibility attaches to them. In England there are very strict laws and regulations regarding the ownership and working of such boilers. In the industrial portion of Bengal also the most stringent regulations have been introduced by the Government, ensuring constant supervision by officials appointed or approved by Government, chiefly at the expense of the users themselves.

Accidents.

No such laws have as yet been introduced into the tea districts of India, because boiler accidents have been hitherto unknown, or of very rare occurrence. As boilers become older, however, the liability to accidents becomes much greater.

n any case it is in the interests of the users themselves o see that the boilers are worked with the greatest care, ,nd to take such precautions as will ensure the longest life ›ossible for the boilers, and the greatest efficiency during hat life. It should be borne in mind that an enormous juantity of fuel may be wasted every day, and a great leal of power constantly lost, by want of proper attention :o the simple rules which ensure cleanliness, efficiency, ınd permanence.

Blowing off.

Boilers require a great deal of care and attention, ›specially if the feed water is at all dirty. Sediment ıaturally settles down, hence the blow-off cocks should be opened for a time every day when the boilers are under steam, when the lirtiest of the water and a great deal of sediment will be cleared out. The cocks should be kept full open till the water in the gauge glass is depressed about two inches. If the feed water is very foul, some water should be blown off several times each day. The boiler should also be emptied once a week and the interior washed out before refilling

Incrustation.

While a boiler is in active operation an enormous quantity of water is evaporated into steam, the water only being taken, and the impurities which had been held in solution are left as a deposit. This change is most active at the inner surface of the boiler tubes, the point where the heat of the fire passes into the water. One result is the formation of a hard film, or scale, all over the tubes, and in a less degree on all other surfaces in the interior of the boiler. This scale is largely heat-resistent, and soon reduces the efficiency of the boiler, causing a great waste of fuel. There are various chemical compositions, such as " Boilerine," which to a large extent prevent the formation of scale, and which can be introduced regularly without difficulty.

Periodically, at least once or twice in the season, boilers should have all sludge doors taken off and be thoroughly cleaned out.

Sludge doors.

Safety valves should be kept in order and arranged so that steam will escape whenever pressure becomes too high. According to Government rules, the safety valve is considered the most important fixture of a boiler. There must be not less than two of these on each boiler, one or both being locked, in order to prevent any tampering with weights or springs. These valves require also to have attached to each a lever, by which the weight or spring can be eased up by hand occasionally, in order to test its efficiency. The reason for this precaution is that in some instances safety valves which had never been operated for many years became so jammed by rust or incrustation as to be perfectly rigid, and explosions were traced to this cause.

Safety valves.

Test cocks and gauge glasses should be kept clean and in working order. The water in the gauge glass should gently rise and fall in sympathy with the boiling of the water inside the boiler ; if the water in the glass is perfectly still, there is reason to suspect that the passages have become blocked, and the cocks must be opened at once in order to test this.

Gauge glasses.

A fusible plug is placed in the fire-box of every boiler as a precaution against explosion. If by any want of care on the part of the fireman, the water in the boiler becomes very low, the plates of the fire-box soon become red-hot. If this is allowed to become much developed, an explosion may result, especially if water is suddenly introduced when the plates are red-hot. The fusible plug is so constructed that it melts away whenever the plates begin to get too hot, and the hole thus made allows a jet of steam to

Fusible plug.

escape into the fire, with the object of putting it out.

Damaged plugs. If a plug becomes partially melted or damaged, it is evidence that the water has been too low; a new plug of the same kind must be inserted in its place. *On no account* should a solid plug of iron or brass be screwed into the hole.

Low water. If by any chance the water has been allowed to fall so low that nothing but steam can be got from gauge glass or test cocks, the fire must be damped at once and water admitted cautiously.

Stoking. The furnaces should be supplied with fuel in small quantities at frequent intervals. The attendant should take note of the progress of the work inside the factory and stoke the furnaces in such a way that when the engines are stopped there will not be an excess of steam, and the furnaces will not be full of fresh fuel. In the case of large boilers great economy in fuel can be effected by attaching mechanical stokers to the furnaces.

Wood fuel. When wood fuel is used, it is most important that a sufficient supply should be laid in for the whole year before the season commences; also that the wood should be perfectly dry. If green or wet wood is used, fully double the quantity will be consumed, and even then it will be difficult to keep up steam when the factory is in full operation.

Stock of wood fuel. For the boilers a stock of wood should be laid in, equal to fully four times the weight of tea for the season; and for the drying machines two times, making a total of six or even seven maunds of wood to every maund of tea.

Emptying boiler. It is not good to empty the whole of the water out of a boiler immediately after blowing off steam. The sudden and irregular cooling down is liable to cause certain parts to get unduly strained. If it has to be emptied for repairs,

better let it stand all night and run the water off in the morning.

Lagging.

All parts of boilers and steam pipes which are not bricked in should be covered with asbestos or other lagging, to prevent waste of heat by radiation. The less steam piping the better, and the fewer bends the better.

Suction Gas.

There is a new type of gas engine plant which is greatly gaining in favour in England for small factories requiring 20 h.p. and upwards. The installation includes an arrangement for the production of *suction gas* directly from anthracite coal, or from coke, or charcoal; the whole plant occupying quite a small space, and the cost of running the engine by this means is so small as to be highly economical; even in towns where ordinary gas can be had at a cheap rate. The suction gas installation is also found to work much cheaper than the ordinary steam engine, and it ought to prove satisfactory on tea estates wherever suitable coal or charcoal can be had.

Shafting should run perfectly true, and the bearings all perfectly level and in line. Ball bearings are best, wherever possible.

Hot bearings.

If any bearing gets hot, it is an indication of something wrong, which should be put right as soon as possible. Unnecessarily heavy shafting is to be avoided, because when running free it takes fully twice the power to turn any shaft which is twice the size of another. Very extensive shafting also means a great deal of friction and consequent loss of power; hence it is desirable to have the machinery arranged as compactly as possible and to keep running only as much shafting as is necessary.

Lubricators.

Only good oil should be used, and every journal supplied with a syphon or lubricator: these being always kept clean and in working order.

For main belts the rope system is in favour in some large factories; it takes an excellent grip and is not heavy. Ordinary cotton belting is also very suitable for this purpose, provide it is of the best quality; but it must never have resin applied to it or be allowed to get wet, in which case it rots rapidly. India-rubber belts will not stand heat.

Belts.

For belts which require to be shifted for starting and stopping machines, leather is perhaps best; it must be the best leather, however, and it should occasionally have a coating of castor oil or other suitable dressing to keep it soft.

Belts never run well when the distance between their pulleys is very short. About 20 to 30 feet is a good workable distance for machine-driving belts. When they are very short, they have to be kept very tight, which is exceedingly bad for the material. On the other hand, when belts are very long, they are heavy, and so add very much to the friction on the journals.

Length of belts.

Belts should not be made to run vertically, because in that position it is almost impossible to get a proper grip on the lower pulley, and the belt must in consequence be kept abnormally tight. Thus it may be summarized—1st, that belts require to run as nearly horizontal as possible; 2nd, they need to be of good length; and 3rd, never drawn very tight. It is an advantage also that the pull on a belt should be on the lower stretch, then whatever slackness there may be will be on the upper stretch and the drooping of it only tends to make the belt cling closer to the pulleys.

Rules for belting.

Pull on belt.

Double belts are not satisfactory. If a single belt is not sufficient to bear the required strain, better run another single one on the top of it; sometimes three belts are run in this way and do exceedingly well. The belting should be a good deal

Double belts.

stronger than what is actually required, and it will then have a much longer life than if continually strained almost to the breaking point. Leather link belts are greatly in favour in English factories, whenever great strength is required.

Double leather belts—two belts sewn together—are not advisable, as they very soon come apart.

Pull opposite.

Shafting and machines should be arranged so that belts are made to pull alternately on opposite ways on the same shaft, and so to a large extent balance the pull and reduce friction on the shaft bearings.

Belt stretchers.

No belt which is wider than four or five inches should be sprung into position. It should be joined up in position on its pulleys with the aid of a belt stretcher of some sort.

Patent machinery.

A great deal of ingenuity has been exercised in the production of machinery suitable for tea manufacture from the crude rolling machine associated with the name of Nelson to the latest thing in "Rapid Rollers," and from the "Almirah" adaptation of chula-drying to the remarkably efficient automatic drying machines now in use.

Only two inventors have held the field for many years. As patents for drying machines have expired, each has benefited to some extent by adopting from the other some details for the improvement of his own machine.

Rolling machines.

Of the many rolling machines which have been put upon the market, none can compare with the "Rapid Roller" which has now been in use for many years, and which has gone through various phases of improvement from time to time. The "*Metallic Rapid,*" with ball bearings, is a remarkably efficient machine, and it takes a very small amount of power to drive for the work done. The single action is less expensive than the double action machine,

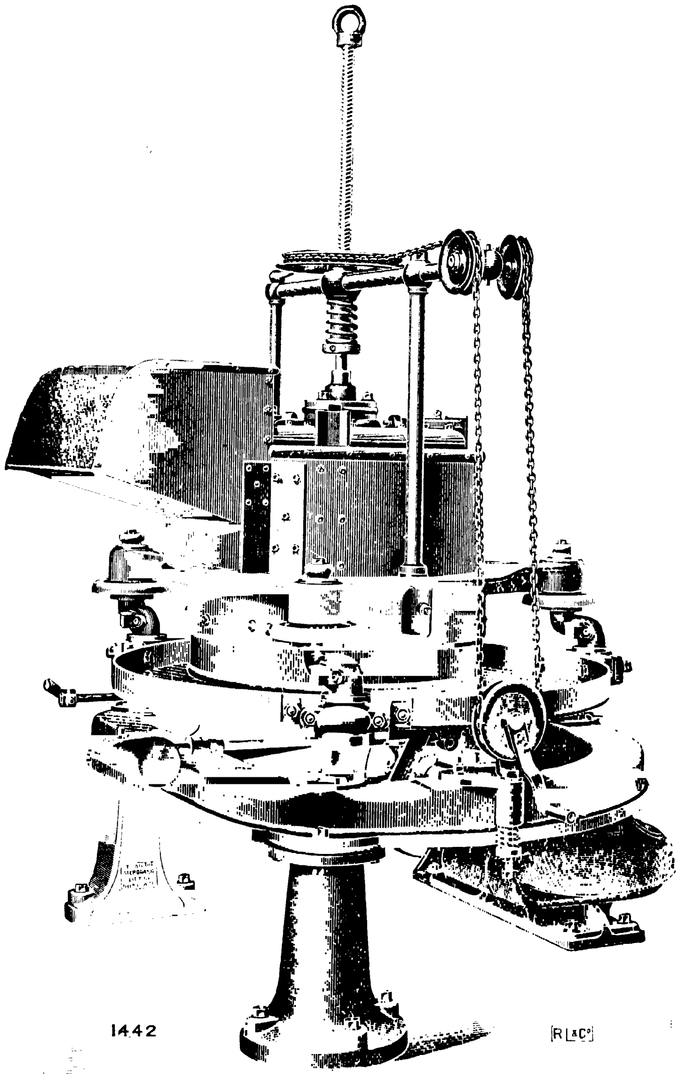

Fig. 39.—Jackson's Patent Double Action Metallic Rapid Roller.

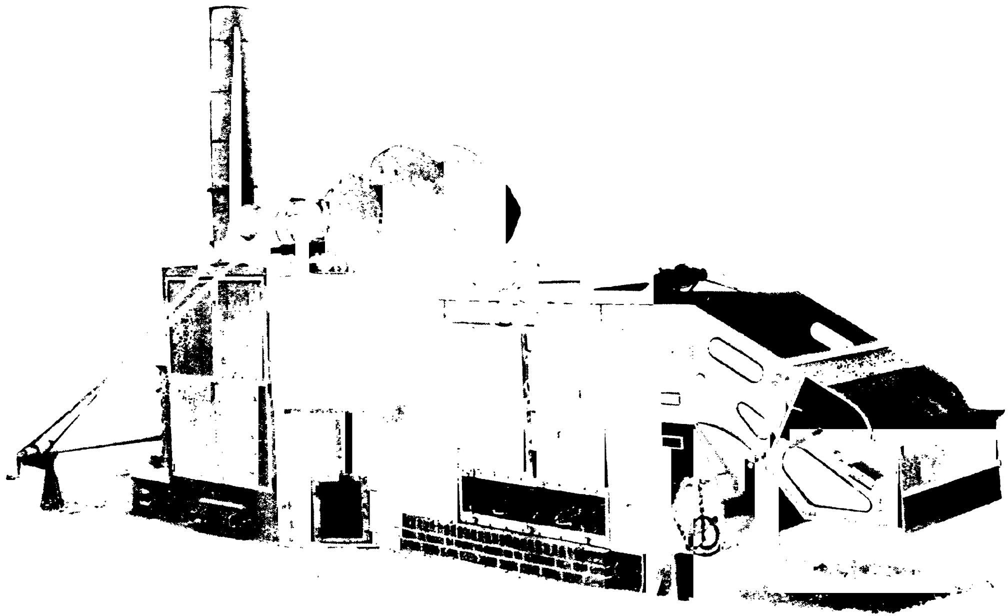

Fig. 31.—Jackson's Patent 4 ft. and 6 ft. Empire Tea Drier.

and is quite as efficient. When specially ordered, these machines can be had with the tables lined with slabs of granite, which is much better than brass; but this adds considerably to the expense.

Expressor.

Perman's "Auto-Expressor" is very useful for estates where there is insufficient withering accommodation, especially during seasons of excessively wet weather. Leaf which has been in the factory for more than eighteen hours without becoming properly withered, can be worked off satisfactorily with the aid of this machine. The leaf is rolled lightly in a rolling machine, and then put into the expressor, which squeezes out all the surplus moisture in a few minutes. The leaf can then get a hard rolling in the usual way, and be put through the ordinary course of manufacture, with very good results.

Drying machines.

As time has gone on the patent machines for drying tea have become increasingly elaborate and expensive, but they have also become the more efficient and economical as improvements in design and detail have been effected. The best machines which have thus far emerged are those known as Jackson's and Davidson's. Both inventors have kept pace with the requirements of the market, and have placed machines suitable for small as well as for large factories.

The "Sirocco" Drying Machines, invented by Davidson, are known wherever tea machinery is used. The latest and best for large factories is the "*Endless Chain Pressure Dryer,*" and it is very highly spoken of by practically all who use it. This machine is made in two sizes, the large size with 6 feet trays, the trays in the small machine being 4 feet long.

The outturn from the latter size is two-thirds that of the large size Pressure Drier. The "*Tilting Tray*" Sirocco, with multi-tubular stove, is suitable for small factories, but is relatively not so good or efficient. The

" *Up-Draft* " Siroccos are used by many planters for final firing. They do a comparatively small amount of work however, and in some factories have been discarded altogether. They do not require power.

The " *Down-Draft* " is perhaps the best known of any " Sirocco " machine, and will be found in tea factories everywhere as this type of Drier has always been a great favourite with planters. It can be supplied with either vertical flue or multi-tubular stoves, the latter being the more efficient.

The " Empire " Drying Machine, by Jackson, is the latest invention of this sort put upon the market, and it already enjoys a reputation similar to that of the Endless Chain Pressure. It is made in two sizes, the smaller being itself a large machine, capable of a very large amount of work. The principle of working is similar to that of the E. C. P., although the arrangement and the details are different. The feeding device of this machine is very simple and efficient. It does not require any attendant to stand over it ; the leaf is merely carried to the machine and thrown into the hopper. The feeder spreads it perfectly. The idea of a pressure fan was first used in the old " Kindmond " Machine, which at one time was in great favour. It operates in such a way as to preserve the best qualities in the tea ; whereas the more recent arrangement with a powerful exhaust fan has tended to whisk away a good deal of the essential oil, with other aromatic and delicate properties of the tea.

Another advantage of the new machines is that some of the heat can be applied to the upper trays direct from the stove, without passing through the lower trays. This improvement can be to some extent introduced in the older machines, by cutting small slits in the dead plate which separates the upper portion of the drying chamber from the stove.

Four slits should be made in this plate, in a line with the second row of trays from the top, the slits being four

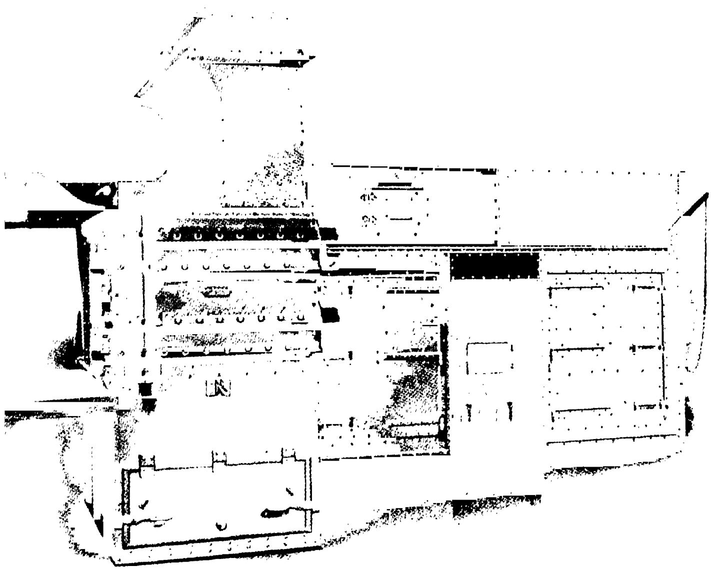

Fig. 32.—Single Tilting Tray Pressure Drier.

inches horizontally, and half inch vertically. The pieces should not be cut out of the plate, but cut on the underside and pushed back, so that the opening will be towards the lower side.

The "Venetian" Tea Dryers are useful for small factories. They are remarkably efficient and economical especially the "Imperial" Venetian, which is the largest of its type, and is fitted with pressure fan. For factories where the power available is very limited these tilting tray machines are a great boon, as they require power only for driving the fan.

Mechanical Stokers.

For the larger drying machines, when the fuel used is coal or coke, a great saving can be effected by having mechanical stokers fixed to the furnaces. These can be fitted to any machine without difficulty, and are not expensive. Not the least benefit in their use is that the stoking can be absolutely regulated, and the air blast thus kept automatically at a uniform temperature.

Oil fuel is now used for drying machines in districts where coal is scarce. Any ordinary furnace can be transformed for its use at small expense.

Fanning machines.

For extracting the fannings and dusts from the teas, no entirely satisfactory machine has yet been put upon the market. For common classes of teas it may not be necessary to separate the fannings, but in the case of fine tippy teas it is quite necessary, and on some of the Darjeeling estates the old crude method of fanning by hand is still employed.

In some factories the ordinary farmer's winnowing machine has been in use for many years. These are the machines which farmers use for fanning out the chaff from seeds and grain, and they are quite effective for the similar purpose in the case of tea. The chief objection to them is that they are generally constructed for hand

driving only, and are too small for dealing with the tea produced in a large factory. Macdonald's "Deflector" Tea Fanner is an adaptation of the winnowing machine, and can deal with a much larger quantity of tea; it has not yet come into general use, although it seems to be steadily gaining in favour.

Strong serviceable sorting machines yare now being made by Robert Roby Ltd., at Bury-St.-Edmunds, England. These are made for power driving, and are well adapted for tea sifting.

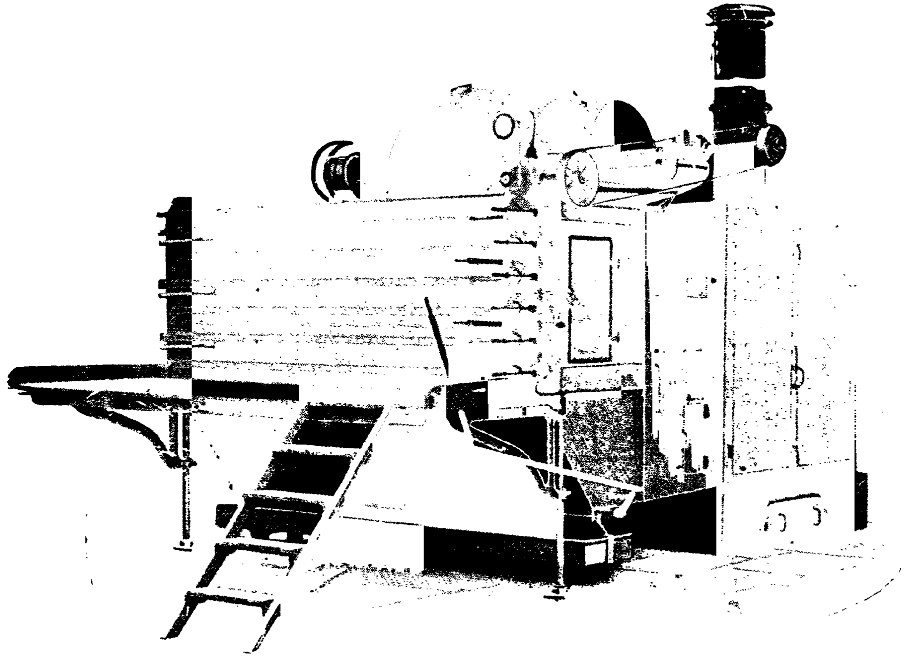

Fig. 34.—Jackson's Patent 10 ft Imperial Venetian Drier.

CHAPTER XXVII.

RAILWAYS AND TRAMWAYS.

ON some large estates, with outlying gardens at a distance, tramway lines have been found exceedingly useful. In a matter like this, however, it is very easy to go too far, and to expend an amount of capital which is not justified by the actual saving of labour effected. It is very seldom that steam power can be necessary for such a line; the rails can be quite light and inexpensive, but the sleepers must be of the best material, because soft timbers will not last long, and a good deal of money soon goes away in constant renewals.

Sleepers.

The chief benefit effected by tramways is that leaf can be brought expeditiously from a distance before it has had time to heat and get spoiled. Another advantage is the saving of labour; two men can push along at a trotting pace a load which ten men could not carry. Lines cannot be laid everywhere, however, and they can only be advantageous where long distances have to be traversed, and where no engineering difficulties block the way.

Advantages.

It is an additional benefit if the line is laid along a route where fuel, etc., has to be carried in the cold weather.

On some estates the leaf tramways have been used with great advantage for carrying soil and manure for top-dressing in the off season. All these items have to be taken into consideration when estimating the desirability for constructing such a line.

Railways for top-dressing.

Wire tramways have of late years come very largely into use in the hill districts of India and Ceylon, chiefly for carrying leaf across ravines, and from distant parts of the estate to the factory.

Wire tramways.

There are several systems of wire tramways in use. The oldest of these consists in an endless wire rope passed round a large grooved pulley at each terminal station. When one pulley is set in motion the whole moves in unison. The old plan is to have two trucks fixed to the rope in such a way that when one is going, the other is returning, and with the wire working on a sufficient slope, the weight of the loaded truck going down the slope sets the whole in motion and brings up the empty truck on the opposite line.

The advantage of this system is that it can be worked on any steep slope, and the speed can be controlled by a brake on the pulley at either end. For loads going down-hill it works automatically, but for level ground or up-hill, power of some sort is required. Where power is used and much material has to be carried, it is customary to have the rope going continuously, and the carriers with the loads are not fixed permanently to the rope, but hitched on one after the other as frequently as required.

Up-hill work.

Continuous lines.

Wherever the line crosses a valley or a gorge, it goes suspended in the air, but whenever it comes near the ground, suitable supports have to be added to keep the wire up, and so keep the passing load at a safe height. The support is merely a column or post, with a cross bar forming a supporting arm at each side.

Supports.

An improvement on the above system is in use, whereby the weight and friction of the working parts is very much lessened. Two strong wire ropes are permanently fixed at the

Double arrangement of wires.

terminal stations. The carriers containing the loads have each a little pulley for running on the fixed wire. An endless wire is passed round terminal pulleys similar to those described above, and is arranged to travel immediately under the fixed wire. This wire rope is quite thin and light. The carriers which run upon the heavy wire are fixed to the light wire and so carried along, the light wire doing the haulage only, while the fixed heavy wire carries the weight. The carrier with its load is kicked off automatically at destination.

Single wire rope.

The most common and useful style of wire tramway is a very simple arrangement, but it can only be used for carrying loads downhill, and then only at a slope of about six or seven degrees; if less slope is used, the loads may sometimes stick half-way, and if a greater slope is used, the loads arrive with destructive force at the terminal.

Workable slope.

Winding arrangement.

This tramway or "shoot" consists of a single fixed wire. The upper end may be fixed to a large tree, or anchored permanently to the ground. It is important that the winding, or tightening arrangement, should be at the lower end, as it is very difficult to pull the upper end with the whole weight of the rope upon it.

The winding arrangement is in the form of a crab winch; the drum for the rope is about 12 inches in diameter and is moved by worm gear, so that there is no possibility of the thing unwinding of itself. The winding apparatus must, of course, be firmly anchored to the ground.

Possible length unsupported.

In the Darjeeling district there is a garden which has a wire tramway stretching across a valley, the distance between the terminals being a mile and-a-half, without supports of any kind. It has been in use for several years, and carries a

load of 40 lbs. with perfect safety. This may, therefore, be taken as a possible stretch. The wire is of the description termed "Lang's Lay," which is the best style of spinning wire rope, and it is of the best steel; the circumference is $1\frac{1}{2}''$ or about $\frac{1}{2}''$ diameter. For moderate stretches, $1\frac{1}{8}''$ circumference is sufficiently strong, if the material is of the best.

Dimensions.

For work of this kind, an improved class of rope is now being introduced. The strands are of solid wire, instead of being compound. This rope is less flexible, but wears very much longer. A fixed rope does not require to be very flexible.

Short tramways.

For short stretches, up to half a mile, the upper end of the rope may be fixed to a large tree, and the winding arrangements may be made of timber, the drum being a piece of tree trunk with holes drilled in it for crowbars with which to wind it round. When the rope is sufficiently taut, a crowbar is inserted in a suitable hole and a batten is put across behind the crowbar by which means the drum is kept from unwinding.

Tight ropes.

It is important that the rope should not be stretched very tight, which means a great strain upon everything, and it will work just as well when comparatively loose.

Runners.

The carriers or runners are simply little grooved pulleys about 3 or 4 inches diameter with hooks attached, to which the load is hung.

Some kinds of runners have an awkward tendency to jump off the line, endangering the lives of any people who may be passing below. The safe kind is that which has a shield coming over the outside of the pulley to guide the rope back into its place again in case of vibration and jerking.

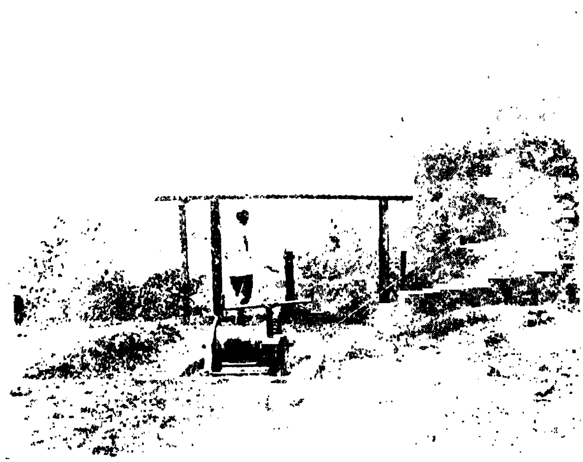

Fig. 35.—Lower Terminal of Single Wire Tramway.

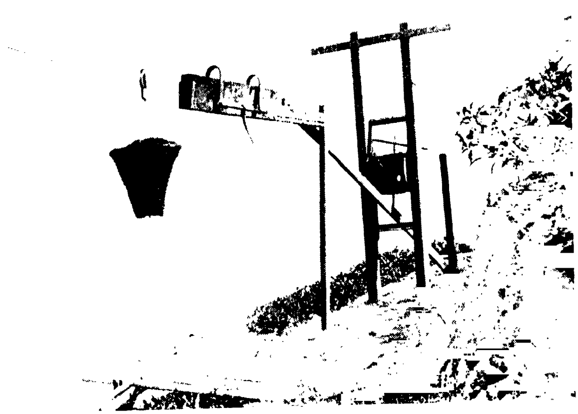

Fig. 36.—Terminal of Wire Tramway for Top-dressing.

In the case of long stretches of rope, care must be exercised to ensure that only one load is on the rope at a time, otherwise disaster may occur.

One at a time.

With tramways of this sort, the runners, with the empty baskets or bags, must be carried back by hand to the starting point for future use.

Returning empties.

Tramways up to half a mile long can be used on hill gardens for top-dressing with great advantage in the off season. It often happens that there is fine soil for this purpose available, but at a place where distance and natural obstacles render the use of it impracticable, unless by means of the wire tramway, which is thus eminently profitable. The saving of labour in this work is enormously greater than in leaf carrying. In this latter case a line may be required to carry only a few loads per day, but when used for top-dressing, it is in use all the time and may carry up to a thousand loads each day.

Wire tramways for top-dressing.

In the case of carrying leaf, the chief benefit is in getting the leaf swiftly to the factory from a distance without heating or damage.

Some sort of buffer is necessary at the lower terminal of the tramway, and various devices have been invented for this purpose. Some of these buffers are rather severe upon the rope itself. A simple and effective style of buffer can be made by banking up a mound of dry earth, against which the load strikes on arrival. This causes very little damage to the load, and of course the buffer is indestructible.

CHAPTER XXVIII.

ACCOUNTS.

Cost of an estate.

THE cost of planting a Tea Estate and bringing it to maturity differs very much in different districts, and also very much according to the manner in which the work is done. The actual value of an estate depends upon two things :—first, the intrinsic value of the land (its suitability for the purpose) ; and second, the manner in which its capabilities have been developed.

Value.

It is easier and cheaper to plant first class land than to plant a poor property.

Forest and grass lands.

Forest land is much more expensive to clear than grass land. The mere fact that there is no forest does not mean that the land is necessarily poor. There are some grass lands which are very rich and fertile ; while there are also some lands covered with forest which are by no means fit for tea. On the whole, however, the finest forest land is better than the finest grass land, but the former is more expensive.

Cost of land.

In the different provinces of India there are certain rules for the sale of waste lands by Government. Where such lands are available, the upset price is usually put at one rupee per acre, together with sundry charges, so that the first cost of land is not very great. Such land is leasehold, bearing rent, but with a practically perennial title. No freehold grants are now made by Government for tea or similar cultivation. When land is purchased from private owners, as much as Rs. 40 to 50 per acre has to be given, or even more, especially if the land is freehold

The price of seed varies very much. Some gardens have been planted with seed which cost Rs. 80, 150 to 200 per maund, or even more, but such prices are never likely to be realized again.

Cost of seed.

Some gardens opened out on forest land have proved exceedingly expensive, costing altogether fully Rs. 1,000 per acre to bring into full bearing. The trees had in the first instance to be paid for on a valuation, and the cost of clearing away enormous trunks and branches proved very heavy; there being no market for the sale of the timber and no labour available for turning it into a suitable form or for storing it properly for future use.

Cost of clearing.

The original cost of an estate is no indication of its real value. The work of planting may have been done so badly as to result in complete failure the first year, involving the repetition of a large proportion of the previous expenditure. Partial failure may follow the efforts of succeeding years, until the property has cost three times the amount which should have been expended, and after all in such cases the plants are sure to be unsatisfactory, irregular in size and shape.

Prime cost no indication of value.

Something like the same result is almost sure to follow when tea is planted upon poor soil or in an unsuitable dry climate; more or less of failure and disappointment means also a waste of both time and money, with a poor property at the end.

Unsuitable conditions.

Clearing and planting has often been done by contract, the rates given being from Rs. 80 to 200 per acre according to the nature of the work.

Planting by contract.

The following gives in rough detail the usual cost of an estate per acre of cultivation, but it must be taken only as approximate, and where agreement labour is

employed, something like Rs. 150 per acre must be added for the cost of importing labour alone.

	Rs.
First year.	
Cost of land, including extra area	10
Seed at Rs. 60 per maund	20
Clearing, planting, temporary buildings, etc.	150
Second year.	
Maintenance, temporary buildings, etc. ...	80
Third year.	
Maintenance	50
Fourth year.	
Maintenance, deducting value of crop ..	20
Permanent buildings and machinery ..	100
At full bearing total Rs. ...	430

Cost of working.

The cost of working an estate varies, but may be reckoned generally at Rs. 110 per acre per annum. Where large crops per acre are obtained, the cost per pound of tea may be very low: in some cases the average cost per pound has been less than 4 annas landed in Calcutta, all expenses included, and several companies have been able to land their tea in London for a fraction less than 4*d.* per pound (3 annas per pound in Calcutta) including all charges. The cost of production has in some other instances been as high as 10*d.* per pound in recent years, but the usual figure is about 7*d.* per pound. in London, equal to 5¾ annas for teas sold in Calcutta reckoning exchange @ 1*s.* 4*d.* per rupee. The cost per pound is greater on hill gardens, making a small crop per acre, than on gardens in a forcing climate.

Hill gardens.

Profit per acre.

Perhaps the best test of the successful working of an estate is the amount of profit per acre. In ordinary years and fairly prosperous times the average profit of tea companies is about £4 to 5 per acre, although some estates have made over £10.

According to published statistics, the capital of 62 Indian tea companies registered in London averages £41, or about Rs. 615 per acre. This includes working capital as well as original cost of estates, and it includes some estates which cost too much, as well as some which were bought for much less than their actual value and much less than their original cost.

Capital account.

Some young companies, after bringing a comparatively small area to a yielding state, went on extending the cultivation year by year from the profits instead of declaring a dividend, with the result that in course of time they had under cultivation, say, 4,000 acres for the same capital which was required to plant the original 2,000 acres, or 1,000 acres, as the case may be. This explains to some extent the very high rates of dividend occasionally declared by certain companies, reaching as high as 40, 60, and even 75 per cent. in one year, although the average profits for tea companies in ordinary circumstances have been about 5 to 10 per cent.

Extending from profits.

Over capitalization may be a mistake, as the rate of dividend can never be very high, but it is a safe course to have a large available capital, provided that the capital is all in ordinary shares. If all the money is not required for working the estates, a portion can always be invested at interest, until some suitable extension calls for its use.

Over capitalization.

A portion of the capital may be in Preference Shares, if the fixed rate of interest is not high; as it meets the case of investors who want a safe investment and are content with moderate interest; but it is not safe to have more than one-fourth of the capital in this form, because this industry, like all others, is subject to times when little or no profits can be made, and any charge which accumulates is a direct menace to the stability of the company.

Preference Shares.

Debentures.

Debentures should be raised only in very exceptional circumstances and the intention should always be to wipe them out at the very first opportunity. For this purpose a sinking fund is quite necessary, to which the greater portion of the annual profits may be placed. Any company which begins by having a large proportion of its capital in debentures is not a safe one.

Borrowed capital.

Debt is of course to be avoided in every case. Anyone who opens out a tea estate on borrowed capital is likely to have all his trouble for nothing.

Depreciation.

In the block account there should always be proper provision made for depreciation. For permanent buildings about 2½ per cent. of their original value should be written off every year, and for machinery about 10 per cent. Some estates which keep no depreciation account charge all new buildings and machinery to revenue, spreading the cost over three years. This saves trouble, but under such a system it is possible that the value of the machinery, etc., on an estate may be allowed to run down to practically nothing, for want of a fund from which renewals may be supplied from time to time. It is better and more correct to charge the whole expenditure to block account, and write off the proper proportion annually, Permanent buildings may be reckoned to last for at least forty years, and machinery on an average for ten years, considering that some machines are liable to become obsolete even before they are worn out. This system necessitates a periodical valuation every fifteen years or so in order to be sure that the block account represents the true state of affairs.

Periodical valuation.

Depreciation of tea.

No company seems to make any provision for depreciation of tea plants or deterioration of the soil, etc. Dr. Mann has declared

more than once that the older gardens of Assam are manifestly deteriorating, while some authorities have stated that the tea plant begins to deteriorate after fifteen years. If this be so, and no steps are taken to meet the loss, the block account ought to be reduced in proportion to the fall in the intrinsic value of the property. In his lecture at the Imperial Institute in 1896, Mr. Christison gave it as his opinion that the tea plant may live for fully 100 years, when growing under the best conditions. If this be taken as the limit, it is manifest that some provision should be made for the time when large numbers of the plants may be dying out, or may become absolutely unproductive.

Possible age of tea.

Some companies have hitherto met this question by extending a small area every year, and are now, with twenty or thirty per cent. more area producing the same quantity of crop as they did twenty years ago. Naturally there is a limit to this, and a certain amount must either be spent upon some definite measures to replace the energy lost by the soil and bushes, or must be deducted from the block account if that account is to continue to represent the true state of the company's assets. To meet the case properly it is necessary to have an account showing the annual deduction for depreciation with a contra, to which may be posted all additions and actual improvements to property.

Annual extensions.

All vacancies are of course to be filled in as they occur after the estate has once been properly and successfully planted: such expenditure may fairly be set off against depreciation. Top-dressing with new soil may be considered in the same light, although in the nature of things it is an operation which cannot be often repeated upon the same block of tea.

Renewals.

Top-dressing.

The advantage of having sufficient working capital must be apparent to all who have studied the matter. It is pitiful to think that a company must borrow from the Bank, or from its Managing Agents at high interest, and hypothecate the crop before it is made, in order to pay its workmen. It is not sound financing, and it would be much better to forego dividends for a year or two in order to have funds on hand to carry on the proper working of the estate. The necessary working capital may be set down at not less than nine months' expenditure, say, £6 or Rs. 90 per acre. There are certain companies which have a considerable reserve of capital invested in Government Securities or otherwise, and yet regularly hypothecate the crop at high interest in order to meet working expenses. Such financing is truly amazing.

Working capital.

Hypothecation of crop.

It is always wise to have a strong reserve fund, made up from profits, which may gradually be increased to 10 or even 15 per cent. of the capital. A company cannot be reckoned as being in a really strong position until it has a good reserve.

Reserve fund.

The monthly accounts should be as simple as possible, and should always be accompanied with an advance account in which is described the nature of the advances, and to whom made, together with a note of the cash actually in the hands of the Manager. A reasonable amount of fluctuation in the amount spent month by month should be allowed, because a good deal has sometimes to be spent upon contract works, which can only be profitably done at certain seasons of the year.

Monthly accounts.

Monthly expenditure.

CHAPTER XXIX.

THE COOLY.

WHENEVER labour is scare, the cooly is undoubtedly master of the situation.

Labour difficulty.

It is a strange thing that in India, with its "teeming millions" and recurring famines, there should ever be anything like a labour difficulty, yet in most of the tea districts such a difficulty is nearly always present, sometimes in quite an acute form.

Over-population.

In India there are immense stretches of country which are rich in agricultural resources, and where each recurring season brings with it the certainty of a good or even an abundant harvest providing ample support for all the inhabitants. There are other provinces, however, which contain thousands of square miles of land, yielding at the best of times only a precarious support for the superabundant inhabitants, and anything like a short crop means immediate and severe distress, and recurring famines literally decimate the population. On the other hand, there are also districts or provinces, such as Assam, where the richness and capabilities of the soil are something marvellous; and yet it is only with the greatest difficulty that labourers can be found for tilling the ground there. The remedy would seem very simple, *viz.*, to draft labour from the overcrowded districts to those places which require it; but this is more easily said than done, and as a matter of fact the planters of Assam have been importing labour into the province for the past sixty years or so with such

Assam's need.

partial success that labour is relatively as scarce now as ever ; enormous numbers of coolies having to be imported every year at great cost, with ruinous bonuses and perquisites thrown in.

Recruitment.

The necessity for these annual importations arises from the fact that a great many of the garden labourers whenever their agreements expire take up land on their own account, and become small farmers under Government, while others return to their own country to spend their accumulated earnings. On the greater part of the immense Province of Assam there is practically no indigenous population. It is to be remembered that very great distances have to be traversed in order to get to Assam, and the Indian, like other people, is very reluctant to leave his home, more often preferring to starve there than to migrate into what is to him a foreign country beyond the misty darkness of the great unknown ; these considerations tell the more strongly for the fact that the ordinary cultivator in India is almost absolutely devoid of any thirst for adventure.

Transformation.

When all the difficulties of the case are considered, there can be nothing but admiration for the results achieved by the planters of Assam, who have transformed immense tracts of wild, inhospitable country into smiling gardens, cultivating the land in such a manner that each two acres supports a family of natives very comfortably, besides providing a portion of the salaries of the Europeans themselves, and of profit for the investors who have risked their money in the enterprise. Besides the direct results of tea planting, the opening up of vast tracts of country, draining swamps, opening up means of communication, and clearing away of noxious grasses and weeds has improved the general conditions of climate and made it possible for the natives themselves to live and thrive and to increase gradually the area under cultivation

for crops of their own. In this way already very considerable areas have been taken up by time-expired coolies from tea estates, and if the Government of India could only see it, the best and simplest way to open up the rich lands of the Assam Valley would be to give every encouragement and help to planters in recruiting from the congested districts of the plains, so that at the expiry of their term of service on the tea estates, they might in still larger numbers settle upon and cultivate the surrounding country as ordinary farmers.

Time-expired labourers.

For many years past the Government of India has exercised a close supervision over the employment of labour on the tea estates of Assam, Cachar, and Sylhet; elaborate laws have after much careful consideration been passed and amended from time to time, in order to regulate not only the conveyance of coolies from their homes to the spot, but also to make sure that each individual agreement is entered into with perfect willingness on the part of the cooly, that his health and comfort, as well as that of his family, are well looked after on the journey and throughout the whole time of their residence on the estate; a Government medical officer of high standing makes periodically a minute inspection of the coolies' quarters to see that the dwellings are comfortable, sanitary arrangements suitable, and hospital accommodation sufficient. A Government Magistrate also pays periodically a visit of inspection to each estate and gives each cooly individually an opportunity to state whether he has any complaint to make regarding his treatment or surroundings. On the other hand, the law aids the planter if any cooly attempts to shirk any part of his agreement, or to abscond from the place before the term of his agreement has expired. The personal supervision which is thus exercised by Government

Government supervision.

Medical inspections.

Magisterial inspections.

is very close and minute, besides the written and detailed reports which it requires to have regularly from the manager of each estate.

Reports.

These labour laws and regulations no doubt ought to be a good thing for the planter as well as the cooly, and they prove to the public in general that there is nothing whatever of the nature of slavery or oppression in the conditions under which the cooly labours ; the details of the arrangements are, however, sometimes felt to be both irksome and unnecessary, and in some points have perhaps been framed more as a result of political theorising than from sympathy with the mutual interests of planter and cooly. When the Government officer is on his round, he cannot ignore the fact that promotion depends to some extent upon his zeal in ferreting out abuses on tea estates ; hence in many cases the inspections have developed into something like systematic bullying of the planters, with the natural result of partial disorganization of the labour force. It has thus gradually become an understood thing that the sympathies of many of the officials in the tea districts are not with the industry as such, but with the labourers, who are supposed to be under the special protection of Government.

Wages.

The question of wages has certainly had more than necessary attention from Government, and in the nature of things might well have been left to a large extent to the natural operation of the laws of supply and demand. The only proviso to this view of the matter is that each agreement should always stipulate, as hitherto, the *minimum* wages agreed upon to be paid, and the *maximum* price which the cooly will have to pay for rice. By this means the cooly can judge before he leaves his home what his income will *at least* amount to, while he is willing to work, and how far it is likely to go ; he is also thus assured that he can never suffer loss through high prices as a result of scarcity

or famine. Besides this fixity in the minimum of income

Labourers' prospects.

the cooly has the prospect of earning extra money in the busy season and, which is of the greatest importance, the possibility of rising to a post of responsibility and comparative ease as an overseer, the wages of these overseers ranging from a rupee or two over that of an ordinary cooly to as much as a hundred rupees or more per month.

Bonus and extras.

As extras each cooly signing an agreement gets a large bonus in money ; he gets a new blanket each year ; he gets a comfortable house, kept in repair at the expense of the estate ; fuel for the carrying in ; hospital accommodation when sick, with skilled medical attendance, food, medicines, and medical comforts, all gratis ; and in many cases he gets a bamboo covering or umbrella for use in wet weather. On many estates schools are provided for the children, where they get free education and have thus a better chance for the well-paid posts which are now quite numerous on every tea estate.

Comparison of condition.

The best way to arrive at a correct opinion with regard to the wages of tea garden coolies is to compare their general condition with that of the cultivators or farmers of the neighbourhood, or of their native province, and in most instances it will be found that the condition of the garden cooly is better almost beyond comparison. He is well-fed, comfortably clothed and housed ; is allowed a weekly day of rest ; can indulge in may little luxuries, including cigarettes, etc.

Drink shop.

A misguided Government has too often placed a temptation in the way of tea estate employees by establishing drink shops on the estates against the wishes of those concerned, chiefly in order that a portion of the earnings of the coolies may help to replenish the exchequer in the shape of excise revenue. The amount of money which is raised in this manner comes to a startling figure and, sad to say, it is steadily increasing. Notwithstanding the sums which

the cooly spends upon small luxuries and upon special occasions, such as feasts at weddings, funerals, etc., he is yet able to save considerable sums of money, which are sent to relatives in his own country as shown by the records of the Postal Money Order Department. In other instances the savings are invested in cows and goats or even in landed property, when the erstwhile cooly moves off to open out and occupy a little farm of his own. Any visitor to a tea estate will be struck at once with the amount of jewellery worn by many of the women and girls at work ; this usually represents the savings which have been made from extra pice at task work, and it is the only safe way which they know of for keeping such savings until they can be merged into some of the larger investments mentioned above.

Saving.

It may not be out of place to quote here from a Resolution by Lord Curzon, as Viceroy of India, after a thorough investigation into the condition of labourers in Assam. The communication is dated 5th February, 1902 :—

Official testimony.

" The advantages which have resulted to Assam from the investment of capital in tea growing can hardly be overstated—indeed, it is to its tea gardens that Assam owes the greater part of its importance as a province. The Government of India, moreover, fully recognise that, whatever view may be taken of the adequacy of the tea garden wage as a remuneration for labour, more than half a million immigrants, drawn from the very poorest classes of India, are indebted to the industry for a much more liberal supply of food and clothing than they could ordinarily have expected to enjoy in their homes...............

" The Governor-General in Council is glad to acknowledge that the relations between the great majority of planters and their coolies are of a kindly nature, that the planter takes a humane interest in the well-being of the

families among whom he lives and with whom he is in almost daily contact, and that the coolies look to their employer with the regard which is ordinarily felt by Indian servants for their masters."

Let the planter of the future maintain the best traditions of his predecessors in regard to his treatment of the labour force, and he will always have a claim upon the consideration of Government and the public in regard to any administrative difficulty which may crop up.

Penal laws.

The penal laws which used to regulate labour in Assam have now been entirely done away with. This step has been taken by Government with the approval of the great majority of planters. The change was made first in Sylhet, after the question had been fully considered by a Special Commission of Planters and Government Officials. The change worked so well in Sylhet that all penal provisions have now been removed from the labour laws for the whole province. The Civil Law of Agreements, known as Act XIII of 1859, is generally recognised as sufficient, so far as the relations between the manager and cooly are concerned. The one drawback to this Act is that if a cooly absconds before the completion of his agreement he can only be proceeded against in the Civil Court for breach of contract. The futility of such procedure is at once apparent to anyone who is acquainted with Indian law courts. In order to surmount this difficulty, a large majority of the owners and agents for tea properties in Assam have formulated and signed a stringent agreement, binding themselves not to entice away one another's coolies or other labour, on pain of a very heavy fine, until such time as the cooly has worked off his agreement and is free to move where he will. In practice this has been insufficient to meet the difficulties in every case, and the planters are practically unanimous in appealing to Government to enact some stringent law against cooly enticement,

Act XIII.

which will be applicable to all concerned, planters and others. Such a law is certainly urgently required, as the cost of recruiting in a legitimate way is so great, that all who undertake to recruit their labour in an honest and straightforward manner are entitled to legal protection. Something like the Indian Labourers' Act in Ceylon would certainly be a step in the right direction. According to it, all coolies are presumed to be under a monthly agreement for service, and must give a full month's notice before leaving; also in the case of a cooly going to a new employer, the latter must procure from the previous employer a discharge ticket. Any employer taking on a cooly without first obtaining his discharge ticket, renders himself liable to a heavy fine and a long term of imprisonment.

An important step has been taken by Government in establishing a Labour Recruitment Bureau, the Chairman of which is a Civil Servant of some experience. One great grievance, however, still remains in that certain overpopulated districts of India are closed against recruitment for Assam, while open for recruitment elsewhere, and even for Colonies outside India.

Communications.

The general conditions regarding recruitment for Assam have greatly changed within the last few years; means of communication have vastly improved; so that the time occupied in travelling to and from the labour recruiting districts is very much less than it was twenty years ago, and there is consequently much less difficulty in garden Sirdars getting their people safely to their destination. On the other hand, the demand for labour has enormously increased; coolies being required for new industries, both in town and country, for mills and mines, for sugar and jute, as well as for the remarkable expansion of trade of all sorts in and around Calcutta. The claims of the latter class were some years

Labour market.

ago considered so important as to justify special investigation and legislation by Government.

Wages.

All these increased demands for labour have naturally had their effect upon the labour market ; the high wages paid for other branches of industry have renderd it imperative that in order to secure labour for the tea districts, a substantial increase of wages must be offered. If by any means the actual cost of recruiting can be reduced, this will not tell seriously upon the industry. It is generally allowed that the average cost of transporting the coolies is capable of being reduced by sixty rupees per head. This would go a very long way towards meeting the expense entailed by a good increase of wages.

Daily rates.

There are some possible improvements which would cost nothing to the estates, and yet would be greatly appreciated by the labourers. Amongst these may be mentioned a *daily* instead of monthly rate of wages, and payment every week.

Non-agreement labour.

In some of the tea districts of India, such as Dooars, Terai, Darjeeling, etc., there is no labour law in force, so that no individual cooly can be put under agreement, and all coolies are free to come and go as they please and when they please. This sometimes gives rise to a condition of things which is far from pleasant for the planter, as, for instance, when from some petty misunderstanding or supposed grievance

Strikes.

the greater part of the labour staff suddenly strikes work, or clears out in the height of the manufacturing season, to be received with open arms into some neighbouring garden, where labour has hitherto been somewhat scarce. The planter has no redress ; the law only allows him to retain what wages may have been due to the coolies at the time, which seems but a mockery at his dire misfortune, it being impossible for him just then to replace the labour

lost. Some of the Sirdars or people may have been owing him large sums of money, but his only remedy is the very doubtful one of sueing for its recovery through civil process in the law court.

Financial losses.

In order to remedy this state of things, it has repeatedly been suggested to the Dooars planters that the agreement labour law should be extended to their district, but they are so impressed with the irksomeness of some of its provisions that they prefer to continue the present system with all its risks and uncertainties, and it speaks volumes for their general treatment of the labour that planters are able to get sufficient numbers to come of their own free will and to stay contentedly for many years, occasionally only going away for a trip at their own expense to visit their friends at home.

Dooars labour.

In districts where the labour is entirely non-agreement, it has been found necessary to adopt what is called the Sirdari system, under which the individual coolies are engaged by a Sirdar and supplied by him to the estate, his remuneration being usually one pice per day for each cooly actually at work. The Sirdar exercises no supervision over the coolies while at work, but is merely in the position of a contractor who supplies the labour. On an estate employing a thousand coolies, there are perhaps ten to thirty of these Sirdars, some supplying only fifteen and some as many as two hundred or more coolies. The most suitable number for any one Sirdar to have is about fifty; because he can live comfortably on the commission from that number, without temptation to swindle them out of any portion of their wages; if, on the other hand, he has a larger number than this, he may become too influential and powerful for the peaceful working of the estate.

Sirdari system.

Size of gangs.

There are some grave objections to the Sirdari system and many managers have from time to time attempted to do away with it altogether, preferring to deal with each cooly directly. This answers very well with those labourers who have some notion of thrift and steadiness of character, but with some classes, such as the Nepaulese, all efforts in this direction have hitherto been either lamentable failures or but very partially successful. So long as there are no financial difficulties, the arrangement works very well, but when a large sum of money is wanted for marriage, or for funeral expenses, the cooly has no fund to fall back upon, and he must raise the money by some means; naturally the manager is unwilling to risk a sum equal to ten or twelve months' wages without any security whatever, and the cooly falls back upon a Sirdar of some neighbouring estate and he absconds to that estate in consequence. It is impossible that a manager could keep an eye upon individual coolies who might be owing sums of money to the estate; the more especially as they can easily slip away to Nepaul or elsewhere, and in any case the cooly who attempts to avoid paying a debt is not in the eyes of the law guilty of anything criminal or punishable

System unsatisfactory.

Financial risks.

For these and such reasons the Sirdari system, although objectionable in itself, must be continued in certain districts until the coolies can be educated up to a better state of things and learn generally to save up something for the future—a thing which thus far is absolutely foreign to the thoughts of most.

Advances.

It is not often that the Sirdar has sufficient, or indeed any, money with which to finance his business, so the manager gives him an advance from the estate. With this money he goes to Nepaul, or to Nagpur, as the case may be, and recruits a lot of coolies; he advances to them enough to pay

their debts and support themselves on the journey to the estate. The Sirdar is responsible to the manager for the money advanced to him, and the coolies are responsible to the Sirdar. When the coolies begin to earn wages, the money due is paid in a lump sum to the Sirdar, less a portion of the debt which is thus recovered, and the Sirdar, who keeps a separate account for each cooly, distributes the money in detail as earned. When special sums are required for marriages, etc., the estate advances it through the Sirdar as before, he being always responsible; but only in very rare cases does the estate reap any interest for money so advanced.

Interest.

Extreme care and great judgment has to be exercised by the manager in this matter of advances. The Sirdar usually has no proper conception of his responsibility, and even when perfectly honest in his intentions will take all he can possibly get, the limit of his asking being not so much what he is likely to require or to be able to repay, as what the manager is likely to give him. When he finds that he has got an advance in excess of the requirements of the case he seldom thinks of returning the balance; he invests it in cattle or ponies for himself, pretending always that he has used the whole of the money for the purpose intended. The day of reckoning, being far off, does not trouble him.

Responsibility.

Excess advances.

The question of debt is a very serious one, and on a tea estate, it sometimes assumes an acute form. The laws regulating the operations of debtor and creditor in India are very unsatisfactory and insufficient, and the whole subject presents perhaps the most serious problem in the internal economy of the country at the present day. The money-lender is everywhere; he belongs to a special caste or guild, and the business

Debt.

Money-lender.

has been passed down from father to son for many generations ; hence his operations are limited to the most profitable fields, and even where apparently very risky, they are guided with almost scientific exactness and certainty. Woe betide the Sirdar who gets into the clutches of these men, and yet at least 50 per cent. of tea garden Sirdars of certain districts are more or less in their power. A Sirdar wants an advance of, say, a hundred rupees, which the manager declines to give, as he considers it unnecessary or insecure ; the Sirdar applies to

Rate of interest.

a lender, who advances it without delay, at interest of one anna per rupee for each month, or no less than 75 per cent. per annum ; this interest being collected monthly, and one month's instalment deducted at once. If the debtor fails to pay the interest, it is added to the principal, which if Rs. 100, at the end of three years, has thus amounted to Rs. 325. The debtor is now confronted by a dilemma, but the

Mode of operation.

creditor is accommodating, and draws up a new bill for the whole Rs. 325 which the debtor signs as "cash received," and then interest, at 75 per cent. begins on this new sum, which goes on until the Indian Shylock reckons that the debt has reached the utmost limit of the man's means, when the debtor is swept into a court of law and his ruin is complete. It is not by any means unusual for cases like the above to occur, and there are instances known to all managers of experience of wretched debtors having been stripped of fabulous sums of money by these land-sharks, as a result of borrowing a small sum in a time of special difficulty. It is not the usual policy, however, of the money-lender to operate directly in the above manner ; he prefers to get payment of interest regularly, and he allows a debtor to become involved just to the extent of his means for repaying, and then steadily draws the interest month by month, the principal remaining unaltered. In this way he gathers in his 75 per cent. per annum,

compound interest, without special trouble or fuss. This quiet system also enables him to widen the circle of his business continually, the pressure actually exerted being all hidden from public view.

Laws for debtors.

It is astounding that any people should be willing to submit to such grinding oppression, and the question naturally arises as to whether the law cannot be altered, so as to deal effectively with such a system of blood-sucking. In some parts of India, Government has attempted to ameliorate the financial condition of raiyats or farmers by the establishment of Agricultural Banks, on the co-operative principle, where small loans can be had on the security of coming crops; all the members of the society being together responsible for the debt of each; but this has no bearing whatever on the case of the tea estate Sirdar; it is merely touching the outer fringe of the subject, and the general trend of things will soon make it necessary for Government to grapple with this difficult problem whether it will or not.

Co-operative credit.

The Co-operative Credit Banks have already proved a great boon to small farmers throughout the country, and are certain to work a revolution in the financial and social conditions of that class. The time may come when these banks will prove also a boon to the labourers on tea estates; but under present conditions there is no room for their operations. In the case of farmers and small cultivators, there is frequently a small amount of money required to finance them while cultivating a coming crop. This can be advanced by the Co-operative Credit Bank; then when the crop matures and is sold, there is a lump sum available wherewith to pay back the loan; but in the case of the cooly on a tea estate there is no lump sum to look forward to, and also there is no need of a loan to supply his daily wants, as he receives his pay regularly week by week. The only times when the cooly requires to borrow are in times of sickness,

or to meet the claims of marriage or funeral expenses. A tea estate manager is always willing to assist in such circumstances, and to lend without interest any sums which may be really necessary. In the free labour districts the money-lender is the worst enemy of the labour force. He invariably appears on the spot on pay-day to carry off a large portion of the earnings of the wretched people. Some estates have passed so completely into the power of these leeches that the latter actually do the whole of the financing for the Sirdars and even the manager is sometimes so misguided as to hand over to them regularly all advances or balances due to the Sirdars on account of coolies' wages, the Sirdars meanwhile signing the receipts as if the money had been paid through them, while the lender arranges for the supply of all necessaries for the coolies day by day, at his own prices, and thus the employees of the estate seldom see money at all. Such a state of things is, of course, most reprehensible, and the manager who submits to it without any attempt at reform is greatly to blame. The difficulty is as to how matters can be improved with the law as it exists at present. The people themselves do not aspire to anything better. The money-lender has always been with them and has always charged a ruinous rate of interest, although he is much more powerful in these days, having now the protection and aid of British Law Courts, backed by a system of Police, from which escape seems well-nigh hopeless, and our modern Shylock is secure not only in enforcing his claims to the very letter, but also in the protection of his vile carcase from any possible attempt at revenge. He appears with his loan of money at convenient times, and the impecunious ones then look upon him as a very useful friend ; future difficulties do not belong to the present and are therefore unheeded.

Money-lenders.

Protection for lender.

Sometimes a manager has made a heroic attempt to deliver his people entirely from the operations of these financiers, and on one occasion a planter in the Darjeeling district fought out with some success for his Sirdars a long series of cases in the Law Courts: agitating at the same time for some amendment in the existing law; but without the latter, all such attempts at a remedy must be either failures or at best mere palliatives. One Deputy Commissioner of Darjeeling went so far in the direction of reform as to pass an administrative order, which practically set aside the existing law, directing that no cultivator on Government lands could be sued for interest to a greater amount than the total sum originally lent. This was not law, however, and could not always be treated as such.

Struggle for reform.

Although the evil cannot be entirely done away with, yet much can be done by restricting the operations of money-lenders as much as possible: by keeping them off the place, and by giving the Sirdars distinctly to understand that if the estate makes advances to them on account of coolies and without interest, it is on condition that they keep entirely out of the clutches of professional money-lenders. Under such circumstances, it is no uncommon thing for a Sirdar to come to the manager and say that in a weak moment he had clandestinely borrowed money and was now in dire difficulty, but that a certain sum would clear him and set him free, when he would never be so foolish again. All this probably means that some money-lender has got him in his power and is exercising unusual pressure; the man has probably named a sum which does not include the principal, but is simply accumulated interest. If any help is given in such circumstance, it is necessary to make sure that the man is actually and literally freed. Even then the trouble is

Restrictions.

Assistance.

not over, because in nine cases out of ten, such a man will soon be in the hands of his enemy again.

If when the man is in difficulties he would only tell the truth, it might be easy for the manager to assist him, but he usually prefers to misrepresent things, and the real position is not disclosed until too late.

Hopeless cases.

In most cases where it is found that a Sirdar has surreptitiously become deeply involved, the manager's wisest course will be to recognise the hopelessness of the man's case, and cast about for a successor to fill his place.

Sirdars' agreements.

Wherever individual coolies may not be brought under agreement, it is very common to take agreements from Sirdars. These men undertake, as contractors, to supply either a definite number of coolies, or to do all they can in that direction. This system answers very well.

The agreement has to be written upon stamped paper, and renewed annually ; but it should be noted that, according to law, in order to be binding, every agreement must be registered at a Law Court.

Sometimes a Sirdar is engaged to supply coolies to several estates ; this, however, is bad policy, and it should be made a necessary condition that the man will live on the estate, and will not supply any coolies anywhere else for any purpose.

Enticing labour.

In times of labour difficulty it has sometimes been felt necessary to offer special inducements in order to encourage labour to come, or to get the largest amount of work possible from those already on the place. It is much to be regretted that these special inducements are sometimes expected to operate more in the way of enticing labour from neighbouring gardens than to get new labour from congested districts. Managers almost invariably repudiate any such intention, but it has been found in

actual experience that some men who were at one time loudest in condemnation of such practices could not resist the temptation or opportunity to take advantage of a neighbour when the actual occasion has arisen.

Combination.

It has often been thought that planters should combine upon this question, and agree not to take one another's coolies on any account without the permission of the manager, who is losing the coolies' services. It is an ideal at which to aim, and has been found quite workable over small areas ; but there are always some men who are opposed to it, generally on the plea that such a rule, when strictly adhered to, interferes with the liberty of the cooly. This objection is not always so unselfish as it appears.

Details of inducements.

Amongst special inducements which have from time to time been offered the most important have been double sirdaree, khorakee or monthly bonus, annual bonus, special pay, land for private cultivation, extra pice, light tasks, with double or even triple pay. The last mentioned item has sometimes been carried to extreme lengths, the task being so light that a number of coolies often did three tasks a day, thus getting, while at work, at the rate of three times their nominal wages. Such a policy is manifestly suicidal because, under the circumstances, a task could not by any stretch of the imagination be taken to represent a fair day's work, and after all, such a system only tends to idleness on the part of the improvident cooly who usually works fewer days a month when he can get double or triple wages for each day. The giving of extra pice for extra leaf or for extra digging, etc., is capable of abuse also, but is more likely to be fair and to work well all-round ; a good rule, however, is that in no case should the extra pice amount to more than one day's wages, except in very unusual circumstances.

Extra pice.

The practice of giving coolies a patch of land to cultivate for themselves has given rise to a most serious state of things. Proprietors of the estates can have no idea of the extent to which in some cases their true interests have been ignored, and the valuable assets of the property literally frittered away by managers who with the idea of getting labour easily, gave *carte blanche* orders for the coolies to take what land they liked. In many instances the finest land of the estate has been seized in this way, and hundreds of acres of very valuable forest swept from the face of the earth by gradual and unchecked encroachments of these cultivators. The direct cost of this to the estate is much more than at first sight appears. A good tea estate may be reckoned to yield in ordinary times about £4 per acre of profit per annum ; if we deduct from this amount interest on capital, say £40 at 5 per cent.=£2, we thus have the remaining two pounds per acre per annum as the actual value of the land given over for the coolies in this way. The worst feature in the case is that often such land which is supposed to be in the possession of the coolies in detail is really in possession of one or two Sirdars or other headmen. These men reap all the benefits absolutely for themselves, and perhaps even force the estate coolies to do some gratis labour for them in addition.

Native cultivation.

Cost to estate.

Abuses.

The indirect losses to the estate are no less serious ; many such estates are now suffering a great deal from the mistakes of the past. Certain persons on the land assume that they have acquired occupancy rights according to law, and that they can neither be turned out nor forced to work on the estate ; there is now no fuel for factory use, and none even for coolies' firewood ; hence the labour difficulty is much greater than ever before, with no prospect of betterment.

Losses involved.

As a matter of principle, it is quite a desirable and right thing that each working cooly should have a small vegetable patch to cultivate on his own account: but if any land is given for this purpose, it should be absolutely restricted to a definite and fixed measure, and kept constantly under supervision, and periodically re-surveyed.

Vegetable patch.

On the general treatment of the labour force much of the success of the estate depends. The importance of this can scarcely be exaggerated. The one great rule to be observed is justice tempered with kindness. Anything like leniency is interpreted by the people themselves as weakness, while indulgence is nothing but sheer folly. Some people have said that gratitude is a trait which is absent from the Indian character, but it is not so; many of the employees of all grades on numbers of tea gardens have become greatly attached to the managers, and would do almost anything for them in appreciation of past acts of kindness; but the native character has suffered from many centuries of oppression and it is not surprising if the surface phase of it is a stolid inability to appreciate or understand an act of kindness done without any ultimate or selfish object in view.

General treatment.

Gratitude.

There are very few estates where there has not been a labour strike at some time or other; the usual cause being an accumulation of either real or fancied grievances. It is a rare thing for natives to flare up at any sudden provocation, and it is also a rare thing for more than one garden to strike work at a time. Often it is only a section of a garden where the coolies strike, and they have adopted this course simply in order to get the ear of the manager for the story of their grievances. It goes without saying that much tact as well as wisdom is required to deal with all such upheavals, more especially if the labour is non-agreement, and still more so if the rupture has

Strikes.

been precipitated by some act of viloence or indiscretion on the part of an assistant, or perhaps even the manager himself. It may be easy to get over the difficulty for the time by sacrificing the assistant, but it is probably neither just nor judicious. In most cases it is well to insist upon the coolies returning to work before any sort of discussion of the situation is allowed, and if the coolies persist in an attitude of defiance, it is probable that neighbouring planters will assist with labour during the difficulty, as has often been done. If the manager is aware of any just grievance, he should rectify it at once, but should absolutely resist any pressure of this kind merely to obtain any special advantages. Anything of the nature of a riot with personal violence is to be suppressed with a strong hand, and in this case the law will render every assistance, provided that neither the manager nor the assistants have themselves resorted to violence.

Neighbourly assistance.

Riot.

It should be made an absolute and unbending rule at all times that no assistant is allowed to lift his hand to strike any employee. There are times when it is exceedingly difficult for a young man to keep his temper, but he should fully realize that if at any time he lifts his hand to strike, it is tantamount to placing his resignation in the hands of his manager. There are other ways of punishing offenders and it is the manager's business to allot such punishments.

Violence.

No appeal should be made to the law except in extreme need. Police officers are best kept off the estate if possible. In all petty quarrels, even such as involve serious damage to limb, it is always best to endeavour to settle the matter on the spot. The natives of India are accustomed to the system of village

Appeals to law.

Panchayats.

panchayats or family courts, and they naturally expect that most differences will be thus settled locally. It is wise always to make use of this idea, and call a panchayat of headmen when necessary, reserving always a final decision for the manager in cases of importance.

It is the acknowledged policy of Government now to recognise panchayats all over the country; and it is an open secret that panchayats will soon be given legal status and definite powers in petty cases.

Fining.

Fining is sometimes necessary and just, but must always be done with caution. If a cooly, in good health, does not accomplish a fair day's work, he should not get a full day's pay; but, on the other hand, if he has done his best, it is unfair to punish him. Sometimes a number of people arrange amongst themselves to force down a task and so they just idle their time, all doing absurdly little; it is better not to fine the whole lot, as they have then a common cause of resentment; better select the worst of them and fine these heavily. Fining should not often be resorted to, and where the management is good, it will seldom be necessary; besides which, good coolies will not stand it. One fact to be remembered is that, it is only the worst class or *budmashes* who suggest a riot or a stampede; good coolies do not, as a rule, rush to extremes when they think they are ill-used. They grumble amongst themselves and perhaps show resentment in petty ways before deciding to go; they wait until they can make suitable arrangements elsewhere, when they just quietly disappear without any apparent reason.

Loss of good coolies

Trades Unions.

It is very seldom that the coolies of a whole district act together. Thus far there are no combinations or organizations which might be described as trades unions, but such a thing is certain to come some time in the future, and the planter

must be prepared to meet it by counter-combination. Anything like animosity, however, is to be avoided, and if the labourers are treated with justice, sympathy, and kindness, there will never be any need for them to seek the protection afforded by doubtful combinations.

APPENDIX.

FORM OF AGREEMENT* UNDER "THE WORKMAN'S BREACH OF CONTRACT ACT."

ACT XIII OF 1859.

FORM OF AGREEMENT.*

An agreement made the day of 19 between Manager Tea Estate, District hereinafter called the employer, of the one part and whose full description and address are given in the schedule hereto annexed, hereinafter called the labourer, of the other part.

1. The labourer hereby agrees to serve as a cooly under the employer in the said Tea Estate for a term of years months days commencing from day of 19 for which $\frac{\text{he}}{\text{she}}$ hereby acknowledges to have received an advance of Rs.—

2. The labourer shall remain and reside on the said Tea Estate and perform all such works as $\frac{\text{he}}{\text{she}}$ may be ordered to do, and which are ordinarily known to be the duties of an ordinary garden cooly to the satisfaction of the employer or the person in charge of the said Tea Estate for the time being.

3. The labourer shall receive wages at the rate of Rs. per mensem, which shall be paid to $\frac{\text{him}}{\text{her}}$ during the month following that in which they are earned

4. The amount of the advance made to the labourer by the employer or any one on $\frac{\text{his}}{\text{her}}$ behalf in cash or otherwise, and the price of any rice or other articles of food supplied to the labourer from the garden godown, shall be set off against the labourer's monthly wages and the labourer shall be entitled only to receive the balance remaining due after such deduction.

5. The labourer shall work out the period of $\frac{\text{his}}{\text{her}}$ contract without interruption and shall not absent himself from $\frac{\text{his}}{\text{her}}$ work without the permission of the employer or the person in charge of the said Tea Estate for the time being.

* There is no form of agreement included in the Act. This form is copied from the Annotated work by Harendra Chandra Singha and Pramode Chandra Dutta, B.L.

6. The labourer shall without objection conform to the rules or practice prevailing in the said Tea Estate as to the hours during which the work is to be done and the measure of work requisite for determining a daily attendance or a full task.

7. In case the labourer shall, before the expiry of the term of this agreement, absent $\frac{\text{himself}}{\text{herself}}$ from $\frac{\text{his}}{\text{her}}$ work without leave, or shall neglect to perform the same, $\frac{\text{he}}{\text{she}}$ shall be liable to be punished according to law and also to compensate the employer for such loss as he may sustain in consequence thereof.

8. In witness whereof the said and have set their hands hereto.

Manager's signature.

Signed and delivered in the presence of

Labourer's signature.

SCHEDULE.

No. of agreement.	Name.	Father's name.	Caste.	Age.	Sex.	Residence. Zilla.	Residence. Thana.	Residence. Mouzah.	The garden in which the labourer last served and the year of such serivce.	Advance received Rs.	His or Her } mark.

Note.—Act XIII of 1859 is meant for the protection of employers who advance money to labourers or artizans under agreement to work for a definite time or till the completion of a certain piece of work.

It is applicable to contracts made with time-expired coolies who have completed their term of labour under Act VI of 1901. It is not applicable to agreements with labourers who have been brought directly from another province, but is applicable to those who have come from another province *of their own accord* seeking work. It is applicable to local labour.

It is not applicable to contractors or to domestic servants.

The agreement may be either verbal or written ; if written, it must be on an eight-anna stamped paper.

There must be an advance of money on account of work to be done, otherwise the Act is not applicable.

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